SAMPLING AND ANALYSIS PLAN
FOR
RED AND BONITA MINE REMOVAL
AND
GOLD KING MINE
SILVERTON, SAN JUAN COUNTY, COLORADO

Prepared for
UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Region 8

Prepared by
WESTON SOLUTIONS, INC.
Region 8 Superfund Technical Assessment and Response Team

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Final Date: June 19, 2015
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For approval signatures, see Worksheet 1 & 2.

Project Dates of Sampling:	June to September 2015
CERCLA ID / Site Spill Identifier No.:	NA/08UP
Contract Name:	START IV
Contract No.:	EP-S8-13-01
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SAP Revision Log

Sites: Red and Bonita Removal and Gold King Mine
OSC: Steven Way
TDDs: 0001/1502-04 and 0001/1408-01

Date	Revision Number	Reason for Change of Scope/Procedures	SAP Section Superseded	Requested By	Approved By
7/10/2015	01	Add additional TDD for Gold King Mine to SAP due to concurrent schedule and add sampling location.	Worksheets: 1&2, 10, 11, 17,18, 20	OSC Steven Way	

List of Acronyms

AES	Atomic Emission Spectrometry
ARSG	Animas River Stakeholders Group
ASTM	American National Standards Institute
BLM	U.S. Bureau of Land Management
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COC	Chain-of-Custody
COR	Contracting Officer Representative
CRQL	Contract Required Quantitation Limits
DRMS	Division of Reclamation Mining and Safety
EDD	electronic data deliverable
EPA	United States Environmental Protection Agency
ERRS	Emergency and Rapid Response Services
ERT	Environmental Response Team
ESAT	Environmental Services Assistance Team
GPM	gallons per minute
GPS	Global Positioning System
HASP	Health and Safety Plan
ICP	inductively coupled plasma/mass spectrometry
L	liter
LLCCV	low level continuing calibration verification
mL/L	milliliters per liter
MS	matrix spike
MSD	matrix spike duplicate
NA	not applicable
OSC	EPA On-scene coordinator
PPE	personal protective equipment
PSI	pounds per square inch
PT	proficiency testing
PTL	Project Team Lead
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
SAP	Sampling and Analysis Plan
SOP	Standard Operating Procedure
START IV	Superfund Technical Assessment and Response Team 4
TAL	Target Analyte List
TBD	to-be-determined
TDD	Technical Direction Document
µg/L	micrograms per liter
UFP-QAPP	Uniform Federal Policy-Quality Assurance Project Plan
WAM	Work Assignment Manager
WESTON	Weston Solutions, Inc.
WQS	Water quality standard

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Introduction

This Sampling and Analysis Plan (SAP) identifies the data collection activities and associated QA/QC measures specific to the Red and Bonita Removal site and the Gold King Mine site (the Site(s)) located near Silverton, San Juan County, Colorado. All data will be generated in accordance with the quality requirements described in the Quality Assurance Project Plan for Region 8 CERCLA Removal and Emergency Response Activities in Colorado, Utah, Wyoming, Montana, North Dakota, and South Dakota (Weston 2013). The purpose of this SAP is to describe site-specific tasks that will be performed in support of the stated objectives. This SAP will reference the QAPP for generic tasks common to all data collection activities including routine procedures for sampling and analysis, sample documentation, equipment decontamination, sample handling, data management, assessment, and data review. Additional site-specific procedures and/or modifications to procedures described in the QAPP are described in the following SAP elements.

This SAP is prepared, reviewed, and approved in accordance with the procedures detailed in the QAPP. Any deviations or modifications to the approved SAP will be documented using the SAP Revision Form. This SAP is produced in accordance with the UFP for QAPPs and consists of the site-specific UFP Worksheets from the QAPP.

Project Organization and Team

Refer to the QAPP Worksheet 3 & 5, and 4, 7, & 8 for the program organizational chart, communication pathways, personnel responsibilities and qualifications, and special personnel training requirements. Project-specific information is provided below.

The following are key individuals identified for this project:

Name	Title/Role	Organization	Receive Copy of SAP?
Steven Way	OSC	EPA	Y
Elliott Petri	Project Team Lead	START	Y
Jan Christner	Principal Engineer	START	Y
Megan Oller	Engineer	START	Y
David Robinson	Project Manager	START	Y

The individuals who will receive a copy of the Program QAPP are specified on QAPP Worksheet 3 & 5 (Project Organization and QAPP Distribution) as noted by the asterisk symbol adjacent to their names. The program QA Manager (QAPP Worksheet 4, 7 & 8) and the Project Manager will maintain the approved QA project plan consisting of the Program QAPP, Project SAP and SAP Document Review Crosswalk. The PTL will distribute the most current copy of the project QA documents via electronic or hard copy, as directed by the OSC. Files for this project will be kept in accordance with Section H.20 of Contract No.: EP-S8-13-01, stating a length of 10 years from close of the project or end of litigation.

QAPP Reference

Weston Solutions, Inc. 2013. Quality Assurance Project Plan for Region 8 CERCLA Removal and Emergency Response Activities in Colorado, Utah, Wyoming, Montana, North Dakota, and South Dakota. Prepared for the START IV Contract. July 2013.

Worksheet 1 & 2 — Title and Approval Page

(UFP-QAPP Manual Section 2.1)
(EPA 2106-G-05 Section 2.2.1)

1. **Project Identifying Information**

   a) **Site Name/Project Name:** Red and Bonita Mine Removal and Gold King Mine

   b) **Site Location/Number:** Silverton, San Juan County, Colorado

   c) **Contract/Work Assignment Number:** EP-S8-13-01/TDD 1502-04 and 1408-01

2) **List Plans and reports from previous investigation relevant to this project.**
URS Operating Services, Inc. 2010. Red and Bonita Mine Remedial Action Field Sampling Plan. Oct 2010
Weston Solutions Inc., 2014. Sampling and Analysis Plan for Red and Bonita Mine. Nov 2014.

Lead Investigative Organization's SAP Author: Elliott Petri / START Project Engineer
Printed Name/Title

7/10/2015
Signature/Date

Lead Investigative Organization's Project Team Leader: Elliott Petri / START Project Engineer
Printed Name/Title

7/10/2015
Signature/Date

Lead Investigative Organization's Technical Manager: David Robinson/WESTON Response Coordinator
Printed Name/Title

7/10/2015
Signature/Date

Federal Regulatory Agency OSC: *Steven Way/OSC* 7/14/15
Printed Name/Title

Signature/Date

Federal Regulatory Agency Delegated Approval Officer:

Printed Name/Title

Signature/Date

Document Control Numbering System: W0217.1F.00458

Worksheet 9 — Project Planning Session Summary

(UFP-QAPP Manual Section 2.5.1 and Figures 9-12)
(EPA 2106-G-05 Section 2.2.5)

Date of Planning Session: 4/23/2015 **Location:** Conference call **Purpose:** Outline site prep work				
Name	**Title/Role**	**Organization**	**Phone No.**	**E-mail Address**
Steven Way	OSC	EPA	303-312-6723	Way.steven@epa.gov
Elliott Petri	Engineer/ PTL	START	303-729-6156	Elliott.petri@westonsolutions.com
Jan Christner	Principal Engineer	START	505-797-1154	Jan.Christner@westonsolutions.com

Notes/Comments: Discuss pond expansion calculations, flocculant and caustic needs, and overall 2015 site work.

Consensus Decisions Made:

- WESTON will prepare a sampling plan, calculate flocculant and caustic requirements, designate caustic and flocculant injection systems, plan and oversee retention pond expansion, operate water treatment injection systems, collect water quality samples, document site activities, and provide on-site technical support as needed during the water treatment system installation and operation, mine entries, and bulkhead installation.

Action Items:

Action	Responsible Party	Due Date
Develop SAP	Elliott Petri	Draft May 19th, 2015
Develop Health and Safety Plan	Elliott Petri	Draft May 19th, 2015
Provide conceptual design for pond expansion within limited available space	Elliott Petri	Sent before meeting
Estimate caustic and flocculant requirements and delivery systems	Elliott Petri	May 15th, 2015
Prepare action plan designating site tasks and responsibilities	Elliott Petri	Draft May 19th, 2015
Provide site assistance	Elliott Petri and additional START members as needed.	July – September 2015

Worksheet 10 — Conceptual Site Model

(UFP-QAPP Manual Section 2.5.2)
(EPA 2106-G-05 Section 2.2.5)

- **Problem Definition**

Red and Bonita

The Red and Bonita site consists of a mine adit and waste rock pile in the Cement Creek watershed. The mine discharges metals-laden water at a flow rate of approximately 300 gallons per minute (gpm). The water flows over a steep waste rock pile, passes through a culvert under a roadway, then flows toward Cement Creek, which discharges to the Animas River in Silverton, Colorado.

EPA and Colorado Division of Mining Reclamation and Safety (DRMS) will be entering the Red and Bonita mine during the field season of 2015 to clean out accumulated solid precipitates prior to installing a bulkhead to eliminate discharge from this mine adit. During the previous mine entries, acid mine drainage and associated solids that were discharged from the mine were treated, settled in the retention pond, and discharged. During this work, the water will be directed to the retention pond to allow precipitate to settle prior to discharge to the traditional flow path.

Gold King

The Gold King site consists of a mine adit and waste rock piles in the Cement Creek watershed. The mine discharges low pH, metals-laden water at a flow rate of approximately 100 gallons per minute (gpm). The water flows through a concrete channel, through a Parshall flume, through a plastic conduit, over a steep waste rock pile, and either into the subsurface (low flow), or toward North Fork Cement Creek. A pond was constructed at the base of the waste rock pile to collect water during 2014 site activities. North Fork Cement Creek flows into Cement Creek, which discharges to the Animas River in Silverton, Colorado.

EPA's ERRS contractor will be opening the mine and stabilizing the portal and adit during 2015 field season to facilitate future evaluation of the mine. Water at the nearby Red and Bonita Mine contains large amounts of particulates that are mobilized when personnel enter the mine. In order to prevent discharge of large amounts of particulates during the Gold King mine entries and portal/adit stabilization, water will be captured, treated, then released downstream of the sites during mine entries and construction.

- **Background Information/Site History**

The Red and Bonita Mine and the Gold King Mine are in the Cement Creek watershed, which originates high in the rugged San Juan Mountains of southwestern Colorado near the San Juan County and Ouray County line on the south slopes of Red Mountain Number 3 and the north slopes of Storm Peak.

The rugged and relatively inaccessible western San Juan Mountains were first prospected in the area around Silverton in 1860. The extension of the railroad from Silverton up Cement Creek to Gladstone in 1899 encouraged the mining of low grade ores, and the establishment of a lead-zinc flotation plant in 1917 allowed for the treatment of the low grade complex

ores found in the area. Over a 100-year period between 1890 and 1991, mining activities in the upper Animas River Basin, including Cement Creek, produced the waste rock and mill tailings sources from which contamination spread throughout the surface water pathway. Over 18 million tons of ore were mined from the Upper Animas River Basin area, with more than 95 percent of this being dumped directly into the Animas River and its tributaries in the form of mill waste. Older waste rock piles and stope fillings were reworked and sent to mills as technology allowed lower grade ores to be processed economically. A great deal of abandoned waste was also milled during World War II when many older mining and milling structures were cannibalized for scrap metal. The last producing mine in the area was the Sunnyside Mine, which ceased production in 1991. The closing of the Sunnyside mine occurred after Lake Emma drained into the mine and out the American Tunnel into Cement Creek in 1978. The flood water from the Lake Emma "blow-out" was reported to have flowed down Cement Creek in a 10-foot wall of water that would have transported a large quantity of tailing and other mine waste down Cement Creek to the Animas River.

Reclamation activities have been ongoing in the Cement Creek basin since 1991 when tailings were removed from the Lead Carbonate Mill site. Remediation work has also been conducted in Gladstone at the American Tunnel waste dump, Mayflower Mill, Gold King #7 Level Mine, Galena Queen, Hercules Mine, Henrietta Mine, and most recently at the Joe and John Mine and the Lark Mine in 2006 and 2007. No new reclamation activities have been initiated in 2008 or 2009.

Numerous historic and now abandoned mines exist within a two-mile radius of Gladstone. They include: the Upper Gold King 7 Level, American Tunnel, Grand Mogul, Mogul, Red and Bonita, Evelyne, Henrietta, Joe and John, and Lark mines. Some of these mines have acid mine drainage that flows between 30 and 300 gpm directly or indirectly into Cement Creek and eventually into the Animas River. The confluence of Cement Creek and the Animas River is located approximately eight miles downstream of Gladstone. The Animas River Stakeholders Group (ARSG), U.S. Bureau of Land Management (BLM), DRMS and private stakeholders have completed remediation projects at the Evelyne, Henrietta, Joe and John, and Lark mines.

The Red and Bonita Mine and the Gold King are the main focus of this sampling effort, however water quality samples will be collected from the Gold King, Mogul, Grand Mogul, Silver Ledge, and American Tunnel mine adits prior to and after installation of the bulkhead in the Red and Bonita Mine. The site locations are shown on Figure 3.

Mine discharges and waste rock piles are the sources of waste at the Red and Bonita Mine. Contaminants are released via oxidation of pyrite within the mine and mine waste pile. Natural dissolution of metal contaminants also occurs in this mineral-rich watershed. Water that flows through the mine and the mine waste pile carries the contaminants to downstream locations via surface water. Water discharged from the site flows to Cement Creek and then to the Animas River, a fishery. Metals generated at the site that are transported via surface water may be attenuated in an adjacent bog and along the flow paths to Cement Creek and the Animas River. There are several additional mines in the area that are also sources of metals to Cement Creek.

Red and Bonita:

Contaminants found in the Red and Bonita discharge water include low pH and metals.

Cadmium concentrations from the mine discharge ranged from 33.3 micrograms per liter (µg/L) to 39.3 µg/L, copper concentrations ranged from 4.5 µg/L to 50.6 µg/L, iron concentrations range from 76,700 µg/L to 97,600 µg/L, lead concentrations ranged from 34 µg/L to 71.2 µg/L, and zinc concentrations ranged from 13,600 µg/L to 17,500 µg/L.

A mine entry was performed during 2012 to investigate the Red and Bonita Mine adit. During the mine entry, precipitates contained within the mine adit to a depth of 2 to 3 feet were disturbed and discharged from the adit, flowed down the tailings pile and along the pathway to Cement Creek, and discharged to Cement Creek. A trail of precipitates was left in the flow path. The disturbance likely caused a release of contaminants greater than would have been discharged had the mine remained undisturbed.

A mine entry was conducted during the week of August 12, 2013. The mine entry was performed to fill data gaps regarding how and where water flows into the mine and where contaminants are generated within the mine. Water treatment, a sedimentation basin, and a filtration system were installed to reduce the potential for discharge of precipitates to Cement Creek during the mine entry.

Another mine entry was also conducted during September 2014 to characterize the properties of the mine for a potential bulkhead location. A packer test was conducted to determine if the chosen location was structurally suitable for a bulkhead that may reduce the impacts to surface water from the mine discharges. During this event, the water was treated with caustic and flocculant then directed to a retention pond to allow precipitate to settle prior to discharge to the traditional flow path.

The 2015 work is being performed to remove solid precipitates from the mine entrance to approximately 25 feet beyond the proposed bulkhead location. Solids will be transported via the mine discharge to the retention pond where precipitates will settle prior to discharge of water to the traditional path. Once the solids are removed the bulkhead will be installed to eliminate discharge from the Red and Bonita Mine adit.

Gold King:

Contaminants in the Gold King discharge water include low pH and metals. From 2009 to 2011, cadmium concentrations from the mine discharge ranged from 38 micrograms per liter (µg/L) to 136 µg/L, copper concentrations ranged from 2400 µg/L to 12,000 µg/L, lead concentrations ranged from 2 µg/L to 29 µg/L, and zinc concentrations ranged from 14,500 µg/L to 44,700 µg/L.

Background Reference:

- URS Operating Services, Inc. 2010. Red and Bonita Mine Remedial Action Field Sampling Plan. October 2010.
- Weston Solutions Inc., 2014. Sampling and Analysis Plan for Red and Bonita Mine. Nov 2014

Worksheet 11 — Project/Data Quality Objectives

(UFP-QAPP Manual Section 2.6.1)
(EPA 2106-G-05 Section 2.2.6)

11.1 State the Problem

EPA, DRMS, and a third party contractor will install a bulkhead in the Red and Bonita Mine during field season 2015 to eliminate the discharge of contaminated water from the mine. Prior to bulkhead installation, a two foot layer of metal precipitate solids must be removed from the floor of the mine from the entrance to a point approximately 25 feet beyond the proposed bulkhead location. The solids will be disturbed and flushed from the mine via the 500 gpm mine discharge and directed toward a settling pond at the base of the waste rock pile where solids will collect for later disposal. When solids are disturbed, the discharge water pH decreases significantly and must be increased to improve solids settling and neutralize water that will be discharged from the site.

The EPA ERRS contractor will open the Gold King Mine, stabilize the portal, and potentially investigate the near-portal workings during field season 2015 to allow additional investigation during subsequent years. Due to the high particulate content present in mine discharges during entries of nearby mines, water will be captured, treated, then released downstream of the site.

EPA has requested that START assist to:

- Develop, help operate, and monitor a water treatment system to increase the pH of adit discharge water and separate solids from the water prior to discharge from the site.
- Document and provide technical assistance for the water treatment pond expansion and verify pond dimensions.
- Assist the ERRS removal contractor with operation of the water treatment system during precipitate removal.
- Sample adit discharges at the Red and Bonita, Gold King, Mogul, Grand Mogul, Silver Ledge and American Tunnel mines prior to sealing of the bulkhead and post bulkhead installation to monitor changes in water quality, metals concentration, and flow rate.
- Document operations associated with bulkhead construction and assist DRMS with monitoring and documenting contractor tasks in accordance with design requirements including underground inspections of the bulkhead construction and concrete testing.

11.2 Identify the Goals of the Study

The goals of the study are to:

- Minimize discharge of particulates discharged from the Red and Bonita Mine and Gold King Sites during precipitate removal.
- Evaluate Red and Bonita Gold King, Mogul, Grand Mogul, Silver Ledge and American Tunnel adit discharge water quality and flow rates before and after bulkhead installation.

- Document that site activities are conducted in accordance with design requirements.

The primary study questions are:

- What is the immediate effect of bulkhead installation on water quality and flow rates of the Red and Bonita, Gold King, Mogul, Grand Mogul, Silver Ledge and American Tunnel?
- Was the settling pond constructed in accordance with plans?
- Is adequate caustic and flocculant being added to ensure effective solids removal in the retention pond? (Interim question during water treatment.)
- Were contaminants released from the site during site activities in excess of what would have occurred if precipitate was left undisturbed?
- Was the precipitate material present in the mine removed adequately?
- Was the bulkhead constructed in accordance with the design plans and specifications?
- What activities occurred at the Red and Bonita site?

11.3 Identify Information Inputs

To support the above objectives, the following data will be collected:

- Analytical results from mine discharge water samples.
- Flow rate measurements of mine discharge water.
- Visual monitoring and field analysis of treatment system influent and effluent and downstream waters. Field analysis may include pH, conductivity, temperature, dissolved oxygen, turbidity, and total suspended solids.
- Results of concrete strength tests and quality documentation.
- Field documentation and photographs of site activities.

11.4 Define the Boundaries of the Study

Spatial Boundaries: The study area includes the Red and Bonita Mine site and Gold King Mine site (Figure 1), including the mine adit and water that flows from the site to Cement Creek and the water flowing from the adits of the Gold King, Mogul, Grand Mogul, Silver Ledge and American Tunnel (Figure 1).

Temporal Boundaries: The study will represent conditions immediately before, during, and immediately after the 2015 mine activities scheduled for July through September 2015. A sampling schedule and sampling plan is included in Worksheets 14, 16 and 17.

Practical constraints on data collection: Scheduling adjustments will be made if physical constraints on planned field events occur due to weather, safety considerations, or problems that may impact the technical quality of the measurements.

11.5 Develop the Analytic Approach

Water will be collected from the adit discharges of the Red and Bonita, Gold King, Mogul, Grand Mogul, Silver Ledge and American Tunnel mines. Samples will be sent for laboratory analysis of total and dissolved TAL metals. Sampling will occur prior to the initial mine entry and after completion and sealing of the bulkhead.

Flow rate measurements will be collected from the adit discharges of the Red and Bonita, Gold King, Mogul, Grand Mogul, Silver Ledge and American Tunnel. Measurements will be taken prior to installation of the bulkhead and after completion and sealing of the bulkhead.

Visual observations and field parameter measurements will be collected periodically in water discharged from the water treatment system toward Cement Creek. It is not anticipated that water quality monitoring data will be directly compared to specific action levels or regulatory limits such as Colorado Water quality standards (WQS) because the data is being collected to document the presence or absence of particulates in discharged water. If the OSC directs that samples be collected from site discharge water, Cement Creek, or the Animas River, the results may be compared to WQS for Animas River Stream Segment 3b (Animas River) or 7 (Cement Creek).

Concrete samples will be collected during the bulkhead concrete pour by a certified concrete testing company. In-field slump testing, temperature, and air entrapment testing will be conducted to ensure workability and that the concrete meets the design specifications. Three sets of concrete cylinders will be poured for strength testing for every five (5) cubic yards of concrete installed; they will be stored as close to the bulkhead as safely possible on a level surface. Two sets will be removed at 7 days for analysis (one set to be tested at 7 days, the other will be laboratory cured and tested 28 days after the concrete pour). The remaining set will be removed and tested 28 days after the concrete pour to assess in-situ curing conditions.

11.6 Specify Performance or Acceptance Criteria

Total and dissolved metals concentrations in the sampled waters are expected to be high relative to the method detection limits, so standard laboratory reporting limits are considered adequate for the purposes of this data. All data will be reviewed and verified to ensure that they are acceptable for the intended use. Data will be validated at the request of the OSC.

Concrete strength and workability will be measured against the requirements outlined in the bulkhead plans and specifications included as Appendix C.

Decision errors will be limited to the extent practicable by following approved U.S. EPA methods and applicable SOPs listed in Worksheet #21 and Appendix B. Any deviation from the SAP will be documented.

11.7 Develop the Detailed Plan for Obtaining Data

The plans and specifications for the bulkhead are provided as Appendix C.

Field water quality parameters will be obtained using a Horiba (U50 or U53) water quality meter. Field monitoring will be used to measure the quality of water discharged from the treatment system, with emphasis on pH and turbidity measurements. Visual observations of

discharge water clarity will be recorded.

If an uncontrolled release of contaminated water and sediment occurs as indicated by the presence of orange stained precipitates in water leaving the site, water between the treatment system and the discharge to Cement Creek and/or other downstream locations may be sampled at the discretion of the OSC. If samples are collected, data from the laboratories will be delivered in an electronic data deliverable and reported in the Site Activities Report.

Worksheet 17 – Sample Design and Rationale, presents the sampling design, and QAPP Worksheets 19, 20, 24-28, and 30 specify analysis design requirements. Appendix D provides the Data Management Plan.

Worksheet 14 & 16 —Project Tasks & Schedule

(UFP-QAPP Manual Section 2.8.2)
(EPA 2106-G-05 Section 2.2.4)

Activity	Responsible Party	Planned Start Date	Planned Completion Date	Deliverable(s)	Deliverable Due Date
Develop a Draft SAP and the EPA Region 8 QA Document Review Crosswalk and Operation Plan	WESTON	4/23/2015	5/21/2015	Draft SAP and the Draft EPA Region 8 QA Document Review Crosswalk	5/21/2015
Address EPA comments on Draft SAP and the Draft EPA Region 8 QA Document Review Crosswalk and Operation Plan	WESTON	Upon receipt from EPA	1 week after receipt from EPA	SAP and the Final EPA Region 8 QA Document Review Crosswalk	1 week after receipt from EPA
Develop HASP	WESTON	5/4/2015	5/31/2015	HASP	Prior to Field Work
Site Work/Field Sampling	WESTON	7/6/2015	9/18/2015	NA	NA
Analytical Tasks*	ESAT	7/6/2015	45 Days after final sample submission to analytical lab	Laboratory Reports	To Weston TL: Receipt of analytical results To EPA: with SAR
Quality Control Tasks*	WESTON	7/6/2015	45 Days after final sample submission to analytical lab	Report of Analyses/Data Package; Data Review or Validation	To Weston TL: Receipt of analytical results To EPA: with SAR
Draft Site Activities Report	WESTON	9/21/2015	3 weeks after receipt of concrete testing report and analytical data	Draft Site Activities Report	3 weeks after receipt of analytical results and concrete testing report
Address EPA comments on Draft Report	WESTON	Upon receipt of comments from EPA	One Week after receipt of comments from the EPA	Final Site Activities Report	2 weeks after EPA comments are received.

* If analysis is performed at the request of the OSC

Worksheet 15 — Project Action Limits and Laboratory-Specific Detection/Quantitation Limits

(UFP-QAPP Manual Sections 2.6.2.3 and Figure 15)
(EPA 2106-G-05 Section 2.2.6)

The following information will be provided for each matrix, analyte, analytical method, and concentration level (if applicable).

Matrix: Water
Analytical Method: 200.7, 200.8
Concentration level (if applicable): Low to High

Analyte	PAL[1]	PAL Reference[1]	PQL Goal	Laboratory Quantitation Limit[2]	Laboratory Detection Limit[2]
TAL Metals – Total and Dissolved	NA	NA	CRQL	CRQL	CRQL
Concrete Slump/Air Tests	25 – 30 cm/ 1–3% air	Design Specification	Design Specification	N/A	N/A
Concrete Field and Strength Testing	3,000 psi @ 7 days 3,400 psi @28 days	Design Specification	Design Specification	TBD	TBD

[1] Links to State regulatory cleanup standards are provided in QAPP Appendix D.

[2] Terminology is project/laboratory-specific.

Worksheet 17 — Sampling Design and Rationale

(UFP-QAPP Manual Section 3.1.1)
(EPA 2106-G-05 Section 2.3.1)

START will collect water samples to characterize water quality and flow impacts from bulkhead installation/closure at the Red and Bonita mine. Samples are expected to be collected from the Red and Bonita, Gold King, Mogul, Grand Mogul, Silver Ledge and American Tunnel mines both prior to mine entry activities and post bulkhead closure (Figure 3). Water samples for total metals analysis will be placed in a 250 milliliter (mL) poly bottle and preserved with nitric acid to pH $\leq$ 2. Water samples for dissolved metals analysis will be filtered with a 0.45 µm filter into a 250 mL poly bottle and preserved with nitric acid to pH $\leq$ 2. Samples will be placed in an iced cooler.
Flows will be measured via temporary flume installation, if flows exceed available flume size a Marsh-McBirney flowmeter will be utilized for flow estimates.

Treatment system discharges will be monitored periodically for pH during operation of the treatment system, and other water quality parameters such as conductivity, TDS, and dissolved oxygen will be measured for as long as the additional information is helpful in determining whether the water treatment system is operating as intended. The target pH will be 6 to 7 standard units. Monitoring data will be noted in the field logbook or on field sheets.

While it is not expected at this time, EPA may direct START to collect samples to characterize the quality of water discharged from the treatment system. Samples will be collected and managed as cited for the mine discharge samples.

START will observe and document the pond expansion and verify expansion dimensions with a Total Station for capacity and retention time calculations. Dimensions will be recorded in the field logbook or field sheets.

START will document the concrete testing and construction of the bulkhead. A third party testing company will be used to conduct the concrete testing. Requirements for the testing are outlined in the bulkhead plans and specifications (Appendix C).

Sample Identification and Handling

Sampling nomenclature for the bulkhead impacts will follow previous sampling efforts of the Animas Watershed and will be as follows:

Sample ID	Associated Mine	Sample Location Detail / Flow Measurement Detail	Latitude / Longitude
CC01C	Grand Mogul	Sample water from the toe of the waste pile Measure flow from upstream of Cement Creek confluence	37 54 35.72 N 107 37 51.66 W
CC02D	Mogul	Sample water downstream of mine pool at the 3 inch flume Measure flow from the 3" Parshall flume	37 54 36.14 N 107 38 17.26 W
CC03D	Red and Bonita	Sample water at the culvert crossing under the road Measure flow from channel prior to culvert crossing	37 53 48.46 N 107 38 41.61 W
CC06	Gold King 7 Level	Sample water from flow leaving the adit Measure flow from adit channel flume.	37 53 40.50 N 107 38 18.09

Sample ID	Associated Mine	Sample Location Detail / Flow Measurement Detail	Latitude / Longitude
			W
CC14	Silver Ledge	Sample water from adit discharge. Measure Flow in the same area as the sample.	37 52 36 20 N 107 38 39 31 W
CC18	Cement Creek	Sample water above Gladstone road crossing Measure flow from same area as water sample.	37 53 28.57 N 107 38 57.07 W
CC19	American Tunnel	Sample flow coming out of the ground Measure Flow from same area as water sample.	37 53 27.50 N 107 38 54.39 W

If samples are collected for site discharge during water treatment at Red and Bonita or Gold King for total and dissolved metals they will be labeled RBSW##mmddyyyy-T/D, where ## is the two digit sample number, with the first sample number being 01, and –T or –D indicate whether the sample is for total or dissolved metals analysis.

Concrete cylinder sets for strength testing will be labeled RBC-01 through RBC-06. Slump tests will be identified as RBS-01 through -06. The third party contractor may have different nomenclature requirements; any changes to the nomenclature will be documented in the field logbook or field sheets.

Samples will be analyzed for the parameters listed on Worksheet 15 and Table 1. Requirements for the sample container, volume, preservation, and QC samples are presented in Table 1: Sampling and Analysis Summary and on Worksheet 19 & 30 of the QAPP.

Sampling and analytical activities performed on site will follow all applicable SOPs outlined in Worksheet 21, including EPA ERT SOP 2001 “General Field Sampling Guidelines”. Sampling is anticipated to be performed in Level D personal protective equipment (PPE).

Worksheet 18 — Sampling Locations and Methods

(UFP-QAPP Manual Section 3.1.1 and 3.1.2)
(EPA 2106-G-05 Sections 2.3.1 and 2.3.2)

Sampling Location / ID	Matrix	Depth (units)	Type	Analyte/Analytical Group	Sampling SOP Reference[1]	Comments
Post-treatment samples at discharge from water treatment system and discharge to Cement Creek, if requested by EPA	Water	NA	Grab	Total and Dissolved Metals	2013	Grab sample collected by dipping container in water.
CC01C	Water	NA	Grab	Total and Dissolved Metals	2013	Grab sample collected by dipping container in water.
CC02D	Water	NA	Grab	Total and Dissolved Metals	2013	Grab sample collected by dipping container in water.
CC03D	Water	NA	Grab	Total and Dissolved Metals	2013	Grab sample collected by dipping container in water.
CC06	Water	NA	Grab	Total and Dissolved Metals	2013	Grab sample collected by dipping container in water.
CC14	Water	NA	Grab	Total and Dissolved Metals	2013	Grab sample collected by dipping container in water.
CC18	Water	NA	Grab	Total and Dissolved Metals	2013	Grab sample collected by dipping container in water.
CC19	Water	NA	Grab	Total and Dissolved Metals	2013	Grab sample collected by dipping container in water.
RBS-##	Concrete	NA	Grab	Concrete Slump Test	C143M – 12	Standard Test Method for Slump of Hydraulic-Cement Concrete
	Concrete	NA	Grab	Concrete Air Entrapment	C173M – 14 C231M - 14	Standard Method via Volumetric Method Standard Method via Pressure Method
RBC-##	Concrete	NA	Grab	Concrete Strength	C 31M-98	Standard Practice for Making and Curing Concrete Test Specimens in the Field

[1] Sampling SOPs references will be provided in Worksheet 21.

Worksheet 20 — Field Quality Control Sample Summary

(UFP-QAPP Manual Sections 3.1.1 and 3.1.2.)
(EPA 2106-G-05 Section 2.3.5)

Matrix	Analyte/Analytical Group	No. of Field Samples[1]	No. of Field Duplicates	No. of MS/MSD [2]	No. of Field Blanks	No. of Equip. Blanks	No. of Trip Blanks	No. of Other	Total No. of Samples to Laboratory
Water	Total Metals	7	1	1	1	0	0	0	9 per sampling event
Water	Dissolved Metals	7	1	1	1	0	0	0	9 per sampling event
Concrete	Compressive Strength	6	0	0	0	0	0	0	1 per 5 cy of concrete

[1] Samples that are collected at different depths at the same location, and analyzed separately, will be counted as separate field samples. Even if they are taken from the same container as the parent field sample, MS/MSDs are counted separately, because they are analyzed separately. If composite samples or incremental samples are collected, only the sample that will be analyzed will be included; subsamples and increments will not be listed separately.

[2] Total number of samples to the laboratory does not include MS/MSD samples.

Note: If EPA requests that field samples be collected from treatment system water and analyzed for total and dissolved metals, the need for a duplicate will be determined based on the rationale for sampling. The number and types of QC samples will be based on project-specific DQOs and this worksheet will be adapted, as necessary, to accommodate project-specific requirements. Project-specific QC samples may include field duplicate, field blank, equipment blank, trip blank, field split, MS/MSD, and PT samples and will be collected in accordance with the frequencies recorded on QAPP Worksheet 12.

Quality Assurance Assessment and Corrective Actions are found in QAPP Worksheet #28.

Worksheet 21 — Field SOPs

(UFP-QAPP Manual Section 3.1.2)
(EPA 2106-G-05 Section 2.3.2)

SOP Number or Reference	Title, Revision, Date, and URL (if available)	Originating Organization	SOP Option or Equipment Type (if SOP provides different options)	Modified for Project? Y/N	Comments
2006	Sampling Equipment Decontamination, 6/2011	U.S. EPA, ERT	NA	N	SOPs are available in Appendix B
2013	Surface Water Sampling, 6/2011	U.S. EPA, ERT	NA	N	SOPs are available in Appendix B
G-12	Specifications and Guidance for Contaminant-Free Sample Containers, 12/1992	U.S. EPA, Office of Solid Waste and Emergency Response	NA	N	SOPs are available in Appendix B
2001	General Field Sampling Guidelines, 6/2011	U.S. EPA, ERT	NA	N	SOPs are available in Appendix B
C31M-98	Standard Practice for Making and Curing Concrete Test Specimens in the Field	ASTM	NA	N	SOPs are available in Appendix B
C143M–12	Standard Test Method for Slump of Hydraulic-Cement Concrete	ASTM	NA	N	
C173M–14	Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method	ASTM	NA	N	
C231M–14	Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method	ASTM	NA	N	

For purposes of this SAP, investigation-derived wastes (IDW) are defined as any byproduct of the field activities that is suspected or known to be contaminated with hazardous substances. The performance of field activities will produce waste products, including spent sampling supplies (disposable scoops) and expendable PPE. IDW will also include soil cuttings and decontamination fluids.

IDW will be managed in accordance with EPA Guide to Management of Investigation Derived Wastes (EPA 1992). Spent sampling supplies and expendable PPE are not anticipated to be considered a hazardous and will be containerized and disposed of in the municipal waste system. Soil cuttings will be returned to the boring or spread around the boring as soon as possible after generation and sampling is complete. Decontamination water will be poured onto the ground close to the boring from which the soil was collected.

Worksheet 22 — Field Equipment Calibration, Maintenance, Testing, and Inspection

(UFP-QAPP Manual Section 3.1.2.4)
(EPA 2106-G-05 Section 2.3.6)

Field Equipment	Calibration Activity	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Title or Position of Responsible Person	Verification	SOP Reference[1]
GPS	Calibrate tape against calibrated steel measuring tape	Clean prior and after each use, check battery	Calibration and operational equipment check	Visually inspect for obvious defects, broken parts, or cleanliness	Prior to use	Equipment operational	Repair/ replace as needed	Field personnel	WAM/COR	Instrument-Specific
Horiba U-50/YSI® 600XLM Water Quality Meters	Calibrate probes with standards per instrument instruction manual	Check batteries, clean probes, store in manufacturer recommended solution	Calibration check	Visually inspect for external damage to probe(s)	Refer to instrument SOP	Refer to instrument SOP	Refer to instrument SOP	Field personnel	WAM/COR	G-13/G-14
Water Flow Instruments	Flume – Measure Size Marsh McBirney – Zero	Flume – clean out upstream debris disturbing laminar flow. Marsh-McBirney – Check Batteries	Flume – N/A Marsh-McBirney – Zero	Flume – Verify flow is through flume not bypassing Marsh-McBirney – Check cables and sensor for wear and tear	Prior to use	Equipment Operational	Flume – Use alternative instrumentation Marsh-McBirney replace batteries/ obtain replacement-	Field Personnel	WAM/COR	Instrument Specific

[1] Refer to Field SOPs (Worksheet 21) and Analytical SOPs (Worksheet 23).

Worksheet 23 — Analytical SOPs

(UFP-QAPP Manual Section 3.2.1)
(EPA 2106-G-05 Section 2.3.4)

Lab SOP Number[1]	Title, Revision Date, and/or Number and URL (if available)	Screening or Definitive Data	Matrix/Analytical Group	SOP Option or Equipment Type	Modified for Project? (Y/N)
TBD	METHOD 6010C INDUCTIVELY COUPLED PLASMA-ATOMIC EMISSION SPECTROMETRY (ICP-AES), 11/2000, http://www.epa.gov/osw/hazard/testmethods/sw846/pdfs/6010c.pdf	Definitive	Water/Soil	ICP-AES	TBD
TBD	METHOD 6020A INDUCTIVELY COUPLED PLASMA-MASS SPECTROMETRY (ICP-MS), 2/2007, http://www.epa.gov/osw/hazard/testmethods/sw846/pdfs/6020a.pdf	Definitive	Water/Soil	ICP-MS	TBD
TBD	C873 / C873M - 10a Standard Test Method for Compressive Strength of Concrete Cylinders Cast in Place in Cylindrical Molds http://www.astm.org/Standards/C873.htm	Definitive	Concrete	Compression Testing Machine	TBD

[1] Lab SOP numbers are lab-specific.

Worksheet 24 — Analytical Instrument Calibration

(UFP-QAPP Manual Section 3.2.2)
(EPA 2106-G-05 Section 2.3.6)

As stated in Worksheet 22, START field personnel are responsible for the calibration of START and sub-contractor provided analytical field equipment. Documented and approved procedures will be used for calibrating, measuring, and testing equipment. Widely accepted procedures, such as those published by U.S. EPA and American National Standards Institute (ANSI), or procedures provided by manufacturers in equipment manuals will be adopted.

The responsibility for the calibration of laboratory equipment rests with the selected laboratories. Each type of instrumentation and each U.S. EPA-approved method have specific requirements for the calibration procedures, depending on the analytes of interest and the sample medium. The calibration procedures and frequencies of the equipment used to perform the analyses will be in accordance with requirements established by the U.S. EPA. The laboratory QA manager will be responsible for ensuring that the laboratory instrumentation is maintained in accordance with specifications. Individual laboratory SOPs will be followed for corrective actions and preventative maintenance frequencies. Laboratory quality control, calibration procedures, corrective action procedures, and instrument preventative maintenance will be included in an addendum to this QAPP once the laboratories have been selected for each sites. Items may include, but are not limited to those identified in the table below.

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Title/Position Responsible for CA	SOP Reference[1]
ICP-AES	See 6010C	Calibration and initial calibration verification after instrument set up, then daily; continuing calibration verifications. Upper range within 10%. New upper range limits should be determined whenever a significant change in instrument response or every six months. Low-level continuing calibration verification (LLCCV) standard with 30%.	Initial and continuing calibration verification within ± 10% of upper range true values and ± 30% LLCCV true values.	Inspect system; correct problem; re-run calibration and affected samples	Lab Manager/ Analyst	6010C
ICP/ ICP-MS	See 6010C, 6020A, ISM01.3	Calibration and initial calibration verification after instrument set up, then daily; continuing calibration verification 10% or every 2 hours, whichever is more frequent	Calibration r2 >0.995; initial and continuing calibration verification within ± 20% of true values	Inspect system; correct problem; re-run calibration and affected samples	Lab Manager/ Analyst	6010C, 6020A, ISM01.3

[1] Refer to the Analytical SOPs table (Worksheet 23).

Worksheet 26 & 27 — Sample Handling, Custody, and Disposal

(UFP-QAPP Manual Section 3.3)
(EPA 2106-G-05 Manual Section 2.3.3)

Examples of field form (QAPP Appendix F), chain-of-custody (QAPP Appendix G), and sample label and custody seal (QAPP Appendix H) documentation are in the QAPP. SOPs for sample handling (identified in the table below) are located in QAPP Appendix I.

Sampling Organization: WESTON
Laboratory: EPA Region 8 Laboratory, ESAT, 16194 West 45th Drive, Golden, CO 80033,
Don Goodrich, Goodrich.donald@epa.gov, 303-312-6687; Mark McDaniel, mcdaniel.mark@epa.gov.
Note –The OSC will review and approve the SAP prior to proceeding with lab procurement. Therefore additional information will not be available until the lab procurement has been finalized.
Method of sample delivery (shipper/carrier): Hand delivered or FedEx
Number of days from reporting until sample disposal: 180

Activity	Organization and Title or Position of Person Responsible for the Activity	SOP Reference
Sample Labeling	WESTON Field Personnel	SOP G-1 & G-3
Chain-of-Custody Form Completion	WESTON Field Personnel	SOP G-8
Sample Packaging	WESTON Field Personnel	SOP G-9
Shipping Coordination	WESTON Field Personnel	SOP G-9
Sample Receipt, Inspection, & Log-in	Laboratory Sample Custodian	Laboratory SOP
Sample Custody and Storage	Laboratory Sample Custodian /Laboratory Analytical Personnel	Laboratory SOP
Sample Disposal	Field Personnel/Laboratory Sample Custodian /Laboratory Analytical Personnel	SOP G-1 & G-3/ Laboratory SOP

Supplies and consumables can be received at a WESTON office, U.S. EPA Warehouse or at a site. When supplies are received at a WESTON office or U.S. EPA Warehouse, the PM or PTL will sort the supplies according to vendor, check packing slips against purchase orders, and inspect the condition of all supplies before the supplies are accepted for use on a project. If the supplies do not meet the acceptance criteria, deficiencies will be noted on the packing slip and purchase order. The item will then be returned to the vendor for replacement or repair. Procedures for receiving supplies and consumables in the field are similar to those described above. Upon receipt, items will be inspected by the WESTON PM or PTL against the acceptance criteria. Any deficiencies or problems will be noted in the field logbook, and deficient items will be returned for immediate replacement.

Worksheet 26 & 27 — Sample Handling, Custody, and Disposal (Continued)

(UFP-QAPP Manual Section 3.3)
(EPA 2106-G-05 Manual Section 2.3.3)

Laboratory Data Deliverables						
Record	**VOCs**	**SVOCs**	**PCBs**	**Pesticides**	**Metals**	**Other/ Concrete**
Narrative					X	X
COC					X	
Summary Results					X	X
QC Results					X	X
Chromatograms						
Tentatively Identified Compounds						

Data collection activities, including sample collection and data generation, will be verified in accordance with the START IV Program QAPP, Worksheet #35. Data will be reviewed for usability in accordance with the START IV Program QAPP, Worksheet #37.

Worksheet 36 — Data Validation Procedures

(UFP-QAPP Manual Section 5.2.2)
(EPA 2106-G-05 Section 2.5.1)

Data Validator: START

Analytical Group/ Method	Data Deliverable Requirements	Analytical Specifications	MPC	Percent of Data Packages to be Validated	Percent of Raw Data Reviewed	Percent of Results to be Recalculated	Validation Procedure	Validation Code[1]	Electronic Validation Program/ Version
Total and Dissolved Metals	Scribe Compatible EDD	QAPP Worksheet 28	Worksheets 11, 12, 19 & 30	100%	0%	0%	U.S. EPA Stage 2A	SV2aE	N/A

[1] Validation Codes are provided in QAPP Appendix M.

Validation will be performed on all laboratory analytical data unless a defined quantity or percentage of samples is identified by the U.S. EPA in the Technical Direction Document or during the project scoping meeting on a project-specific basis. Project validation criteria as per QAPP Worksheets 12, 15, 19 & 30, 28, and 36, and cited EPA SW-846 methodology will be used. WESTON-contracted laboratory data packages will be verified and validated using a Stage 2A validation, as described in the EPA *Guidance for Labeling Externally Validated Laboratory Analytical Data for Superfund Use* (January 2009) (QAPP Appendix J) unless otherwise specified by the U.S. EPA WAM/COR during the development of the DQOs. Validation Qualifiers will be applied using the following hierarchy: Region 8 UFP-QAPP for Removal Actions and Emergency Responses; the site-specific SAP, and/or QAPP; *EPA National Functional Guidelines for Organic Data Review* (QAPP Appendix K); *EPA National Functional Guidelines for Inorganic Data Review* (QAPP Appendix L); EPA Publication SW-846; and the laboratory-specific SOP. Methods for which no data validation guidelines exist will be validated following the guidance deemed most appropriate by the data validator.

The data validator will receive all laboratory packages and analytical results electronically. Additionally, the validator will be required to submit final validation reports via PDF format and must provide an annotated laboratory analytical result electronic data deliverable (EDD) with applicable data validation qualifiers (QAPP Appendix M) identified in the site-specific SAP, and/or QAPP, and/or result value modifications. The Delegated QA Manager will use EPA document *Using Qualified Data to Document an Observed Release and Observed Contamination* (July 1996) to aid in determining the use of qualified data to document all observed release and observed contamination by chemical analysis under U.S. EPA's HRS. Approved data will be released by the Delegated QA Manager for reporting.

QAPP Worksheet 35 describes the issue resolution process and the individual responsible for conveying results to data users. For issues internal to the laboratory, the laboratory PM will be the responsible party for data resolution issues and will be responsible for conveying this information to the Delegate QA Manager or delegated authority. For external laboratory data and quality issues, the Delegated QA

Manager or delegated authority will provide issue resolution information and will be the responsible party for conveying this information to data users. For quality documents, reports, and field information, the Delegated QA Manager, delegated authority, or other persons identified in the table in QAPP Worksheet 35 will be responsible for issue resolutions of such items and will be the responsible party for conveying that information to data users.

TABLES

File Extension

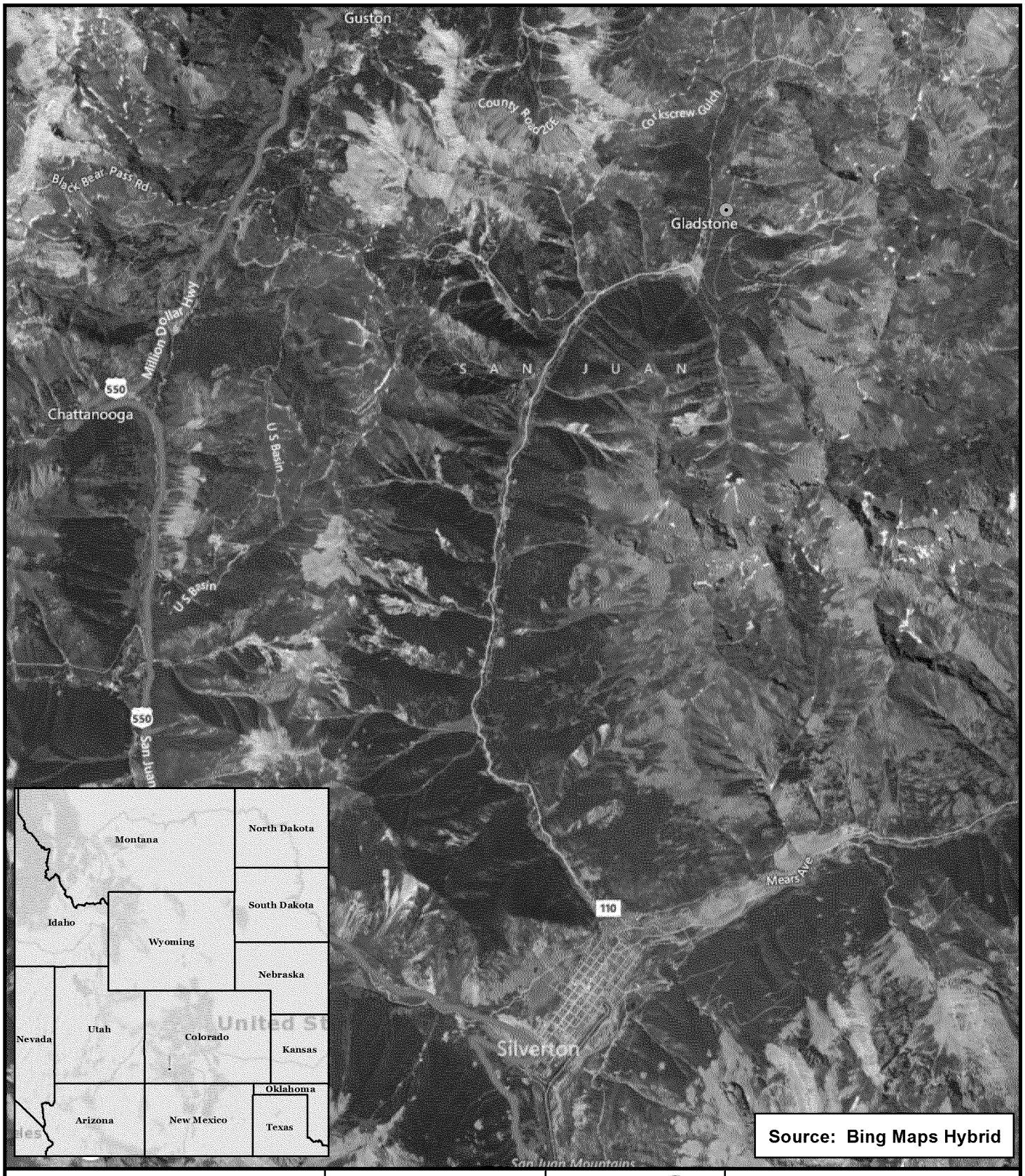
Table 1
Sampling and Analysis Summary

Site: Red and Bonita Removal
OSC: Steven Way
TDD: 1502-03

Matrix	Analytical Parameter	Analytical Method	Containers (Numbers, Size, and Type)	Preservation Requirements	Number of Sampling Locations	Number of Field Duplicates	Number of MS/ MSDs[2]	Number of Blanks (Trip, Field, Equip. Rinsate)[1]	Total Number of Samples to Lab[3]	Holding Time
Water	Total Metals	200.7, 200.8	One 250 mL poly bottle	Nitric acid to pH<2	6 per event	1 per event	1 per event	0	8 per event	6 months
Water	Dissolved Metals	200.7, 200.8	One 250 mL poly bottle	Filtered then preserved with nitric acid to pH≤2	6 per event	1 per event	1 per event	0	8 per event	6 months
Concrete	Compressive Strength	C873 / C873M - 10a	Cylinders size TBD	0	6	0	0	0	1 per 5 cy of concrete	Destroyed @ 7 & 28 Days

Notes:
[1] Trip blanks are only required for VOCs in water samples.
[2] For the samples designated for MS/MSDs, triple volume is required for VOCs and double volume for other water parameters.
[3] Total number of samples to the laboratory does not include MS/MSD samples.
* Samples will be collected only if requested by the OSC.
°C – Degrees Celsius
Equip. – Equipment
MS/MSD – Matrix Spike/Matrix Spike Duplicate

FIGURES



Legend

Site Location

0 0.5 1 2 Miles

Prepared for:
U.S. EPA Region 8

Contract No.:
EP-S8-13-01

TDD:
1502-04

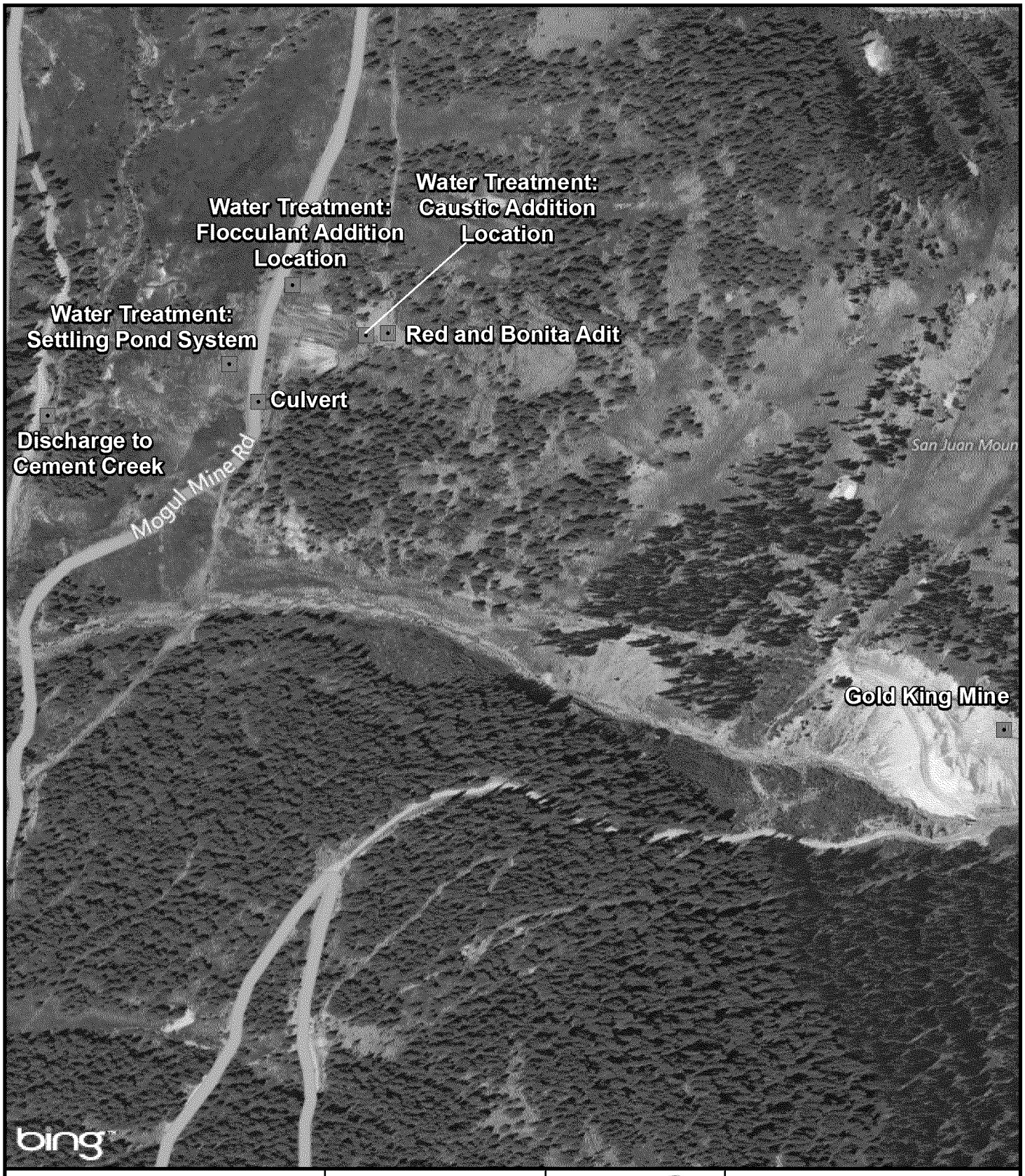
TO:
0001

Prepared By:
Weston Solutions, Inc.
START IV

Suite 100
1435 Garrison Street
Lakewood, CO 80215

FIGURE 1
SITE LOCATION MAP
RED AND BONITA MINE/
GOLD KING MINE
SAN JUAN COUNTY,
COLORADO

Date: 7/9/2015



Legend

Sampling Locations

0 155 310 620 Feet

Prepared for:
U.S. EPA Region 8

Contract No.:
EP-S8-13-01

TDD:
1502-04

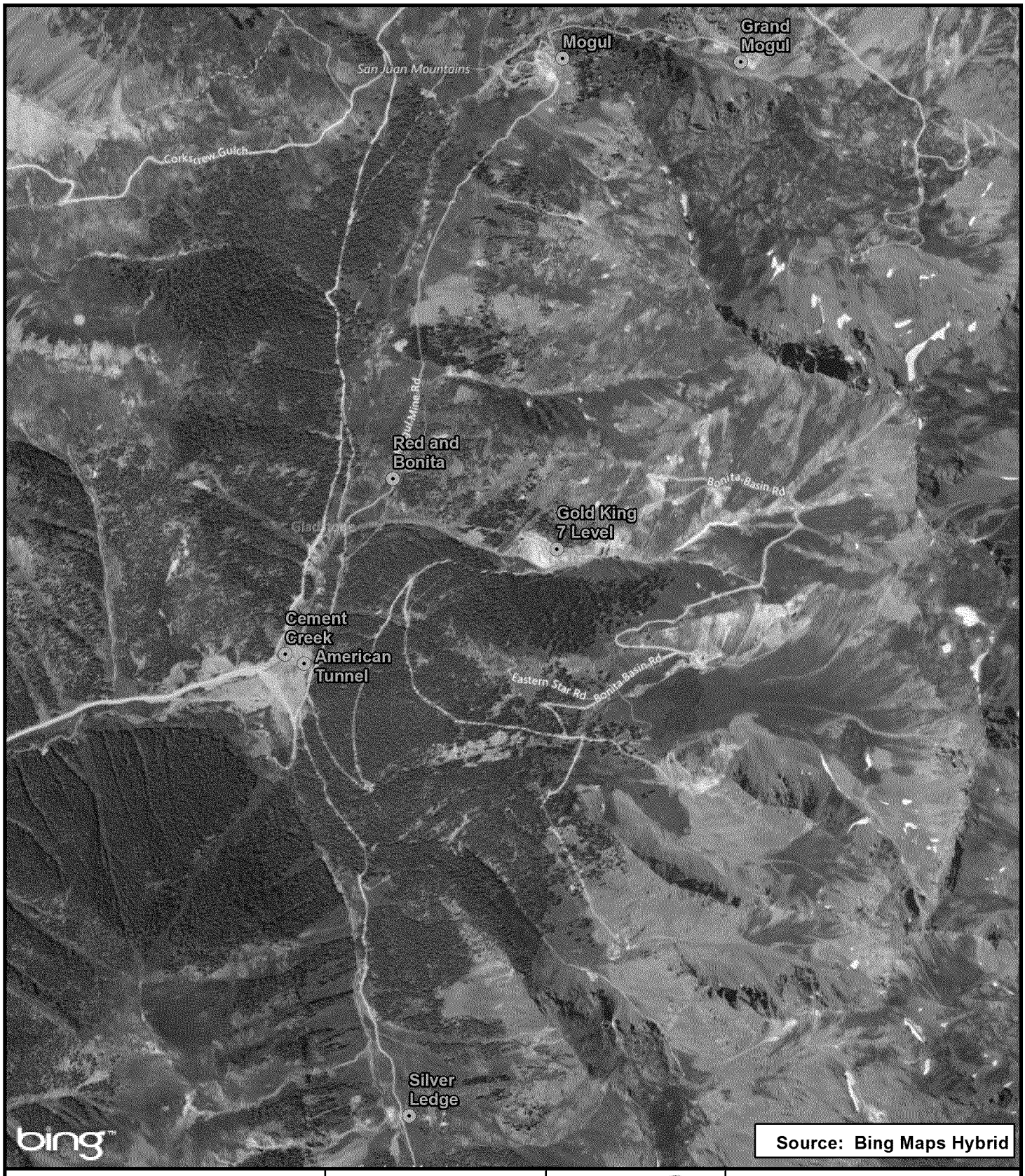
TO:
0001

Prepared By:
Weston Solutions, Inc.
START IV

Suite 100
1435 Garrison Street
Lakewood, CO 80215

FIGURE 2
SITE DETAILS
RED AND BONITA MINE/
GOLD KING MINE
SAN JUAN COUNTY,
COLORADO

Date: 7/9/2015



Legend

Mine Adit Discharge Sampling Locations

0 700 1,400 2,800 Feet

Prepared for:
U.S. EPA Region 8

Contract No.:
EP-S8-13-01

TDD:
1502-04

TO:
0001

Prepared By:
Weston Solutions, Inc.
START IV

Suite 100
1435 Garrison Street
Lakewood, CO 80215

FIGURE 3
MINE ADIT DISCHARGE SAMPLING LOCATIONS
RED AND BONITA MINE/ GOLD KING MINE
SAN JUAN COUNTY, COLORADO

Date: 7/9/2015

APPENDICES

Appendix A

EPA Region 8 QA Document Review Crosswalk

EPA REGION 8 QA DOCUMENT REVIEW CROSSWALK

QAPP/FSP/SAP for: *(check appropriate box)* [ ] **GRANTEE** [ ] **CONTRACTOR** [X] **EPA** [ ] **Other**	**Entity** *(grantee, contract, EPA AO, EPA Program, Other)* EPA – Emergency Response	**Regulatory Authority and/or Funding Mechanism**	___**40 CFR 31 for Grants** ___**48 CFR Part 46 for Contracts** ___ **Interagency Agreement** ___ **EPA Administrative Order** ___ **EPA Program Funding** ___ **EPA Program Regulation** ___ **EPA CIO 2105**
Document Title *[Note: Title will be repeated in Header]*	Sampling and Analysis Plan for Red & Bonita Mine Removal and Gold King Mine		
QAPP/FSP/SAP Preparer	Weston Solutions, Inc.		
Period of Performance *(of QAPP/FSP/SAP)*	1 year from date of EPA approval of Task Level QAPP	**Date Submitted for Review**	June 19, 2015
EPA Project Officer **EPA Project Manager**	Joyce Ackerman Steven Way	**PO Phone #** **PM Phone #**	303-312-6822 303-312-6723
QA Program Reviewer or Approving Official		**Date of Review**	

Documents to Review:

1. QAPP written by Grantee or EPA must also include for review:
   Work Plan(WP) / Statement of Work (SOW) / Program Plan (PP) / Research Proposal (RP)

2. QAPP written by Contractor must also include for review:
   a) Copy of signed QARF for Task Order
   b) Copy of Task Order SOW
   c) Made available hard or electronic copy of approved QMP
   d) If QMP not approved, provide Contract SOW

3. For a Field Sampling Plan (FSP) or Sampling & Analyses Plan (SAP), the Project QAPP must also be provided.
   OR
   The FSP or SAP must be clearly identified as a stand-alone QA document and must contain all QAPP required elements (Project Management, Data Generation/Acquisition, Assessment and Oversight, and Data Validation and Usability).

Documents Submitted for QAPP Review:

1. QA Document(s) submitted for review:

QA Document	Document Date	Document Stand-alone	Document with QAPP
QAPP	**07/31/13**	Yes / No	
FSP		Yes / **No**	Yes / No
SAP	**09/5/14**	Yes / No	Yes / No
SOP(s)			Yes / No

2. WP/SOW/TO/PP/RP Date ___EP-S8-13-01_____
WP/SOW/TO/RP Performance Period
___3/30/2016_____

3. QA document consistent with the:
WP/SOW/PP for grants? Yes / No
SOW/TO for contracts? **Yes** / No

4. QARF signed by R8 QAM Yes / No / NA
Funding Mechanism IA / contract / grant / NA
Amount _____

Summary of Comments *(highlight significant concerns/issues)*:

1. Comment #1
2. Comment #2
3. Comment #3
4. The EPA – Emergency Response must address the comments in the Summary of Comments, as well as those identified in the Comment section(s) that includes a "Response (date)" and Resolved (date)".

Element	Acceptable *Yes/No/NA*	Page/ Section	Comments
A. Project Management			
A1. Title and Approval Sheet			
a. Contains project title	Y	Title Page and Introduction Worksheet 1 & 2	
b. Date and revision number line (for when needed)	Y	Title Page and Revision Log	
c. Indicates organizations name	Y	Title Page	
d. Date and signature line for organizations project manager	Y	Worksheets 1 & 2, 4, 7 & 8	
e. Date and signature line for organizations QA manager	Y		
f. Other date and signatures lines, as needed	Y	Worksheets 1 & 2, 4, 7 & 8	
A2. Table of Contents			
a. Lists QA Project Plan information sections	Y	Table of Contents, List of Appendices	
b. Document control information indicated	Y	Worksheet 1 & 2, Revision Log	
A3. Distribution List			
Includes all individuals who are to receive a copy of the QA Project Plan and identifies their organization	Y	Worksheet 3 & 5	
A4. Project/Task Organization			
a. Identifies key individuals involved in all major aspects of the project, including contractors	Y	Worksheet 3 & 5, 6, 4, 7, & 8	
b. Discusses their responsibilities	Y	Worksheet 4, 7 & 8, 6	
c. Project QA Manager position indicates independence from unit generating data	Y	Worksheet 3 & 5, 4, 7 & 8	
d. Identifies individual responsible for maintaining the official, approved QA Project Plan	Y	Worksheet 4, 7 & 8, Revision Log	
e. Organizational chart shows lines of authority and reporting responsibilities	Y	Worksheet 3 & 5	
A5. Problem Definition/Background			
a. States decision(s) to be made, actions to be taken, or outcomes expected from the information to be obtained	Y	Worksheet 11	
b. Clearly explains the reason (site background or historical context) for initiating this project	Y	Worksheet 10	
c. Identifies regulatory information, applicable criteria, action limits, etc. necessary to the project	Y	Worksheets 11, 15	
A6. Project/Task Description			

a. Summarizes work to be performed, for example, measurements to be made, data files to be obtained, etc., that support the projects goals	Y	Worksheets 11, 14 & 16	
b. Provides work schedule indicating critical project points, e.g., start and completion dates for activities such as sampling, analysis, data or file reviews, and assessments	Y		
c. Details geographical locations to be studied, including maps where possible	Y	Worksheets 10, 11	
d. Discusses resource and time constraints, if applicable	Y		
A7. Quality Objectives and Criteria			
a. Identifies - performance/measurement criteria for all information to be collected and acceptance criteria for information obtained from previous studies, - including project action limits and laboratory detection limits and - range of anticipated concentrations of each parameter of interest	Y	Worksheets 12.1 & 12.2	
b. Discusses precision	Y	Worksheets 12, 36, 37	
c. Addresses bias	Y		
d. Discusses representativeness	Y		
e. Identifies the need for completeness	Y		
f. Describes the need for comparability	Y		
g. Discusses desired method sensitivity	Y		
A8. Special Training/Certifications			
a. Identifies any project personnel specialized training or certifications	Y	Worksheet 4, 7 & 8	
b. Discusses how this training will be provided	Y		
c. Indicates personnel responsible for assuring training/certifications are satisfied	Y		
d. identifies where this information is documented	Y		
A9. Documentation and Records			
a. Identifies report format and summarizes all data report package information	Y	Worksheets 14 & 16, 29	
b. Lists all other project documents, records, and electronic files that will be produced	Y	Worksheet 14 & 16	

c. Identifies where project information should be kept and for how long	Y	Worksheet 29	
d. Discusses back up plans for records stored electronically	Y		
e. States how individuals identified in A3 will receive the most current copy of the approved QA Project Plan, identifying the individual responsible for this	Y	Worksheet 4, 7 & 8	
B. Data Generation/Acquisition			
B1. Sampling Process Design (Experimental Design)			
a. Describes and justifies design strategy, indicating size of the area, volume, or time period to be represented by a sample	Y	Worksheet 11, 17	
b. Details the type and total number of sample types/matrix or test runs/trials expected and needed	Y	Worksheets 17, 18	Unknown number of samples
c. Indicates where samples should be taken, how sites will be identified/located	Y		
d. Discusses what to do if sampling sites become inaccessible	Y	Worksheet 17	
e. Identifies project activity schedules such as each sampling event, times samples should be sent to the laboratory, etc.	Y	Worksheets 14 & 16	
f. Specifies what information is critical and what is for informational purposes only	Y	Worksheet 17	
g. Identifies sources of variability and how this variability should be reconciled with project information	Y	Worksheet 17	
B2. Sampling Methods			
a. Identifies all sampling SOPs by number, date, and regulatory citation, indicating sampling options or modifications to be taken	Y	Worksheet 21	
b. Indicates how each sample/matrix type should be collected	Y	Worksheet 19 & 30	
c. If in situ monitoring, indicates how instruments should be deployed and operated to avoid contamination and ensure maintenance of proper data	Y	Worksheet 22	
d. If continuous monitoring, indicates averaging time and how instruments should store and maintain raw data, or data averages	NA	Worksheet 22	

e. Indicates how samples are to be homogenized, composited, split, or filtered, if needed	Y	Worksheet 21	
f. Indicates what sample containers and sample volumes should be used	Y	Worksheet 19 & 30	
g. Identifies whether samples should be preserved and indicates methods that should be followed	Y		
h. Indicates whether sampling equipment and samplers should be cleaned and/or decontaminated, identifying how this should be done and by-products disposed of	Y	Worksheet 21	
i. Identifies any equipment and support facilities needed	Y	Worksheet 22	
j. Addresses actions to be taken when problems occur, identifying individual(s) responsible for corrective action and how this should be documented	Y	Worksheets 17, 31, 32 & 33	
B3. Sample Handling and Custody			
a. States maximum holding times allowed from sample collection to extraction and/or analysis for each sample type and, for in-situ or continuous monitoring, the maximum time before retrieval of information	Y	Worksheet 19 & 30	
b. Identifies how samples or information should be physically handled, transported, and then received and held in the laboratory or office (including temperature upon receipt)	Y	Worksheet 26 & 27	
c. Indicates how sample or information handling and custody information should be documented, such as in field notebooks and forms, identifying individual responsible	Y		
d. Discusses system for identifying samples, for example, numbering system, sample tags and labels, and attaches forms to the plan	Y		
e. Identifies chain-of-custody procedures and includes form to track custody	Y		
B4. Analytical Methods			
a. Identifies all analytical SOPs (field, laboratory and/or office) that should be followed by number, date, and regulatory citation, indicating options or modifications to be taken, such as sub-sampling and extraction procedures	Y	Worksheet 23	
b. Identifies equipment or instrumentation needed	Y	Worksheets 23, 24	
c. Specifies any specific method performance criteria	Y	Worksheet 24	

d. Identifies procedures to follow when failures occur, identifying individual responsible for corrective action and appropriate documentation	Y		
e. Identifies sample disposal procedures	Y	Worksheet 26 & 27	
f. Specifies laboratory turnaround times needed	Y	Worksheet 19 & 30	
g. Provides method validation information and SOPs for nonstandard methods	Y	Worksheets 23, 36	
B5. Quality Control			
a. For each type of sampling, analysis, or measurement technique, identifies QC activities which should be used, for example, blanks, spikes, duplicates, etc., and at what frequency	Y	Worksheet 20	
b. Details what should be done when control limits are exceeded, and how effectiveness of control actions will be determined and documented	Y	Worksheet 28 - Identifies general criteria. Actual inputs determined on a project-specific basis	
c. Identifies procedures and formulas for calculating applicable QC statistics, for example, for precision, bias, outliers and missing data	Y	Worksheet 37	
B6. Instrument/Equipment Testing, Inspection, and Maintenance			
a. Identifies field and laboratory equipment needing periodic maintenance, and the schedule for this	Y	Worksheets 22, 24	
b. Identifies testing criteria	Y		
c. Notes availability and location of spare parts	Y		
d. Indicates procedures in place for inspecting equipment before usage	Y	Worksheets 22, 24	
e. Identifies individual(s) responsible for testing, inspection and maintenance	Y		
f. Indicates how deficiencies found should be resolved, re-inspections performed, and effectiveness of corrective action determined and documented	Y	Worksheets 22, 24	
B7. Instrument/Equipment Calibration and Frequency			
a. Identifies equipment, tools, and instruments that should be calibrated and the frequency for this calibration	Y	Worksheet 25	
b. Describes how calibrations should be performed and documented, indicating test criteria and standards or certified equipment	Y	Worksheet 25	

c. Identifies how deficiencies should be resolved and documented	Y		
B8. Inspection/Acceptance for Supplies and Consumables			
a. Identifies critical supplies and consumables for field and laboratory, noting supply source, acceptance criteria, and procedures for tracking, storing and retrieving these materials	Y	Worksheet 26 & 27	
b. Identifies the individual(s) responsible for this	Y		
B9. Use of Existing Data (Non-direct Measurements)			
a. Identifies data sources, for example, computer databases or literature files, or models that should be accessed and used	Y	Worksheet 13	
b. Describes the intended use of this information and the rationale for their selection, i.e., its relevance to project	Y		
c. Indicates the acceptance criteria for these data sources and/or models	Y		
d. Identifies key resources/support facilities needed	Y		
e. Describes how limits to validity and operating conditions should be determined, for example, internal checks of the program and Beta testing	Y		
B10. Data Management			
a. Describes data management scheme from field to final use and storage	Y	Worksheets 11, 26 & 27, 29, 35	
b. Discusses standard record-keeping and tracking practices, and the document control system or cites other written documentation such as SOPs	Y	Worksheets 26 & 27, 29	
c. Identifies data handling equipment/procedures that should be used to process, compile, analyze, and transmit data reliably and accurately	Y	Worksheets 22, 23, 29	
d. Identifies individual(s) responsible for this	Y	Worksheet 29	
e. Describes the process for data archival and retrieval	Y		
f. Describes procedures to demonstrate acceptability of hardware and software configurations	Y	Worksheets 22, 23	
g. Attaches checklists and forms that should be used	Y		
C. Assessment and Oversight			
C1. Assessments and Response Actions			

a. Lists the number, frequency, and type of assessment activities that should be conducted, with the approximate dates	Y	Worksheet 31, 32 & 33	
b. Identifies individual(s) responsible for conducting assessments, indicating their authority to issue stop work orders, and any other possible participants in the assessment process	Y		
c. Describes how and to whom assessment information should be reported	Y		
d. Identifies how corrective actions should be addressed and by whom, and how they should be verified and documented	Y		
C2. Reports to Management			
a. Identifies what project QA status reports are needed and how frequently	Y	Worksheet 31, 32 & 33	
b. Identifies who should write these reports and who should receive this information	Y		
D. Data Validation and Usability			
D1. Data Review, Verification, and Validation			
Describes criteria that should be used for accepting, rejecting, or qualifying project data	Y	Worksheet 36	
D2. Verification and Validation Methods			
a. Describes process for data verification and validation, providing SOPs and indicating what data validation software should be used, if any	Y	Worksheets 34, 35, 36	
b. Identifies who is responsible for verifying and validating different components of the project data/information, for example, chain-of-custody forms, receipt logs, calibration information, etc.	Y	Worksheet 35	
c. Identifies issue resolution process, and method and individual responsible for conveying these results to data users	Y	Worksheets 35, 36	
d. Attaches checklists, forms, and calculations	Y	Worksheet 34	
D3. Reconciliation with User Requirements			
a. Describes procedures to evaluate the uncertainty of the validated data	Y	Worksheets 11, 12, 35, 36	
b. Describes how limitations on data use should be reported to the data users	Y	Worksheet 36	

Appendix B

Selected Standard Operating Procedures

SURFACE WATER SAMPLING

SOP#: 2013
DATE: 11/17/94
REV. #: 0.0

1.0 SCOPE AND APPLICATION

This standard operating procedure (SOP) is applicable to the collection of representative liquid samples, both aqueous and non-aqueous from streams, rivers, lakes, ponds, lagoons, and surface impoundments. It includes samples collected from depth, as well as samples collected from the surface.

These are standard (i.e., typically applicable) operating procedures which may be varied or changed as required, dependent upon site conditions, equipment limitations or limitations imposed by the procedure or other procedure limitations. In all instances, the ultimate procedures employed should be documented and associated with the final report.

Mention of trade names or commercial products does not constitute U.S. Environmental Protection Agency (EPA) endorsement or recommendation for use.

2.0 METHOD SUMMARY

Sampling situations vary widely, therefore, no universal sampling procedure can be recommended. However, sampling of both aqueous and non-aqueous liquids from the above mentioned sources is generally accomplished through the use of one of the following samplers or techniques:

- Kemmerer bottle
- Bacon bomb sampler
- Dip sampler
- Direct method

These sampling techniques will allow for the collection of representative samples from the majority of surface waters and impoundments encountered.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

Once samples have been collected, the following procedure should be followed:

1. Transfer the sample(s) into suitable, labeled sample containers.
2. Preserve the sample if appropriate, or use pre-preserved sample bottles. Do not overfill bottles if they are pre-preserved.
3. Cap the container, place in a ziploc plastic bag and cool to 4°C.
4. Record all pertinent data in the site logbook and on field data sheets.
5. Complete the Chain of Custody record.
6. Attach custody seals to cooler prior to shipment.
7. Decontaminate all sampling equipment prior to the collection of additional samples with that sampling device.

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

There are two primary interferences or potential problems with surface water sampling. These include cross contamination of samples and improper sample collection.

1. Cross contamination problems can be eliminated or minimized through the use of dedicated sampling equipment. If this is not possible or practical, then decontamination of sampling equipment is necessary. Refer to the Sampling Equipment Decontamination SOP.

2. Improper sample collection can involve using contaminated equipment, disturbance of the stream or impoundment substrate, and sampling in an obviously disturbed area.

Following proper decontamination procedures and minimizing disturbance of the sample site will eliminate these problems.

5.0 EQUIPMENT/APPARATUS

Equipment needed for collection of surface water samples may include (depending on technique chosen):

- Kemmerer bottles
- Bacon bomb sampler
- Dip sampler
- Line and messengers
- Sample bottles/preservatives
- Ziploc bags
- Ice
- Coolers
- Chain of Custody records, custody seals
- Field data sheets
- Decontamination equipment
- Maps/plot plan
- Safety equipment
- Compass
- Tape measure
- Survey stakes, flags, or buoys and anchors
- Camera and film
- Logbook/waterproof pen
- Sample bottle labels

6.0 REAGENTS

Reagents will be utilized for preservation of samples and for decontamination of sampling equipment. The preservatives required are specified by the analysis to be performed.

7.0 PROCEDURES

7.1 Preparation

1. Determine the extent of the sampling effort, the sampling methods to be employed, and the types and amounts of equipment and supplies needed.

2. Obtain the necessary sampling and monitoring equipment.

3. Decontaminate or pre-clean equipment, and ensure that it is in working order.

4. Prepare scheduling and coordinate with staff, clients, and regulatory agency, if appropriate.

5. Perform a general site survey prior to site entry, in accordance with the site specific Health and Safety Plan.

6. Use stakes, flagging, or buoys to identify and mark all sampling locations. If required the proposed locations may be adjusted based on site access, property boundaries, and surface obstructions. If collecting sediment samples, this procedure may disturb the bottom.

7.2 Representative Samplin g Considerations

In order to collect a representative sample, the hydrology and morphometrics of a stream or impoundment should be determined prior to sampling. This will aid in determining the presence of phases or layers in lagoons, or impoundments, flow patterns in streams, and appropriate sample locations and depths.

Water quality data should be collected in impoundments, and to determine if stratification is present. Measurements of dissolved oxygen, pH, and temperature can indicate if strata exist which would effect analytical results. Measurements should be collected at one-meter intervals from the substrate to the surface using the appropriate instrument (i.e., a Hydrolab or equivalent).

Water quality measurements such as dissolved oxygen, pH, temperature, conductivity, and oxidation-reduction potential can assist in the interpretation of analytical data and the selection of sampling sites and depths when surface water samples are collected.

Generally, the deciding factors in the selection of a sampling device for sampling liquids in streams, rivers, lakes, ponds, lagoons, and surface impoundments are:

1. Will the sample be collected from shore or from a boat?

2. What is the desired depth at which you wish to collect the sample?

3. What is the overall depth and flow direction of river or stream?

4. What type of sample will be collected (i.e., water or lagoon liquids)?

7.2.1 Sampler Composition

The appropriate sampling device must be of a proper composition. Selection of samplers constructed of glass, stainless steel, PVC or PFTE (Teflon) should be based upon the analyses to be performed.

7.3 Sample Collection

7.3.1 Kemmerer Bottle

A Kemmerer bottle (Figure 1, Appendix A) may be used in most situations where site access is from a boat or structure such as a bridge or pier, and where samples at depth are required. Sampling procedures are as follows:

1. Use a properly decontaminated Kemmerer bottle. Set the sampling device so that the sampling end pieces (upper and lower stoppers) are pulled away from the sampling tube (body), allowing the substance to be sampled to pass through this tube.

2. Lower the pre-set sampling device to the predetermined depth. Avoid bottom disturbance.

3. When the Kemmerer bottle is at the required depth, send down the messenger, closing the sampling device.

4. Retrieve the sampler and discharge from the bottom drain the first 10-20 mL to clear any potential contamination of the valve. Transfer the sample to the appropriate sample container.

7.3.2 Bacon Bomb Sampler

A bacon bomb sampler (Figure 2, Appendix A) may be used in situations similar to those outlined for the Kemmerer bottle. Sampling procedures are as follows:

1. Lower the bacon bomb sampler carefully to the desired depth, allowing the line for the trigger to remain slack at all times. When the desired depth is reached, pull the trigger line until taut. This will allow the sampler to fill.

2. Release the trigger line and retrieve the sampler.

3. Transfer the sample to the appropriate sample container by pulling up on the trigger.

7.3.3 Dip Sampler

A dip sampler (Figure 3, Appendix A) is useful in situations where a sample is to be recovered from an outfall pipe or along a lagoon bank where direct access is limited. The long handle on such a device allows access from a discrete location. Sampling procedures are as follows:

1. Assemble the device in accordance with the manufacturer's instructions.

2. Extend the device to the sample location and collect the sample by dipping the sampler into the substance.

3. Retrieve the sampler and transfer the sample to the appropriate sample container.

7.3.4 Direct Method

For streams, rivers, lakes, and other surface waters, the direct method may be utilized to collect water samples from the surface directly into the sample bottle. This method is not to be used for sampling lagoons or other impoundments where contact with contaminants is a concern.

Using adequate protective clothing, access the sampling station by appropriate means. For shallow stream stations, collect the sample under the water surface while pointing the sample container upstream; the container must be upstream of the collector. Avoid disturbing the substrate. For lakes and other impoundments, collect the sample under the water surface avoiding surface debris and the boat wake.

When using the direct method, do not use pre-preserved sample bottles as the collection method may dilute the concentration of preservative necessary for proper sample preservation.

8.0 CALCULATIONS

This section is not applicable to this SOP.

9.0 QUALITY ASSURANCE/ QUALITY CONTROL

There are no specific quality assurance (QA) activities which apply to the implementation of these procedures. However, the following general QA procedures apply:

1. All data must be documented on field data sheets or within site logbooks.

2. All instrumentation must be operated in accordance with operating instructions as supplied by the manufacturer, unless otherwise specified in the work plan. Equipment checkout and calibration activities must occur prior to sampling/operation and they must be documented.

10.0 DATA VALIDATION

This section is not applicable to this SOP.

11.0 HEALTH AND SAFETY

When working with potentially hazardous materials, follow U.S. EPA, OSHA and corporate health and safety procedures.

More specifically, when sampling lagoons or surface impoundments containing known or suspected hazardous substances, adequate precautions must be taken to ensure the safety of sampling personnel. The sampling team member collecting the sample should not get too close to the edge of the impoundment, where bank failure may cause him/her to lose his/her balance. The person performing the sampling should be on a lifeline and be wearing adequate protective equipment. When conducting sampling from a boat in an impoundment or flowing waters, appropriate boating safety procedures should be followed.

12.0 REFERENCES

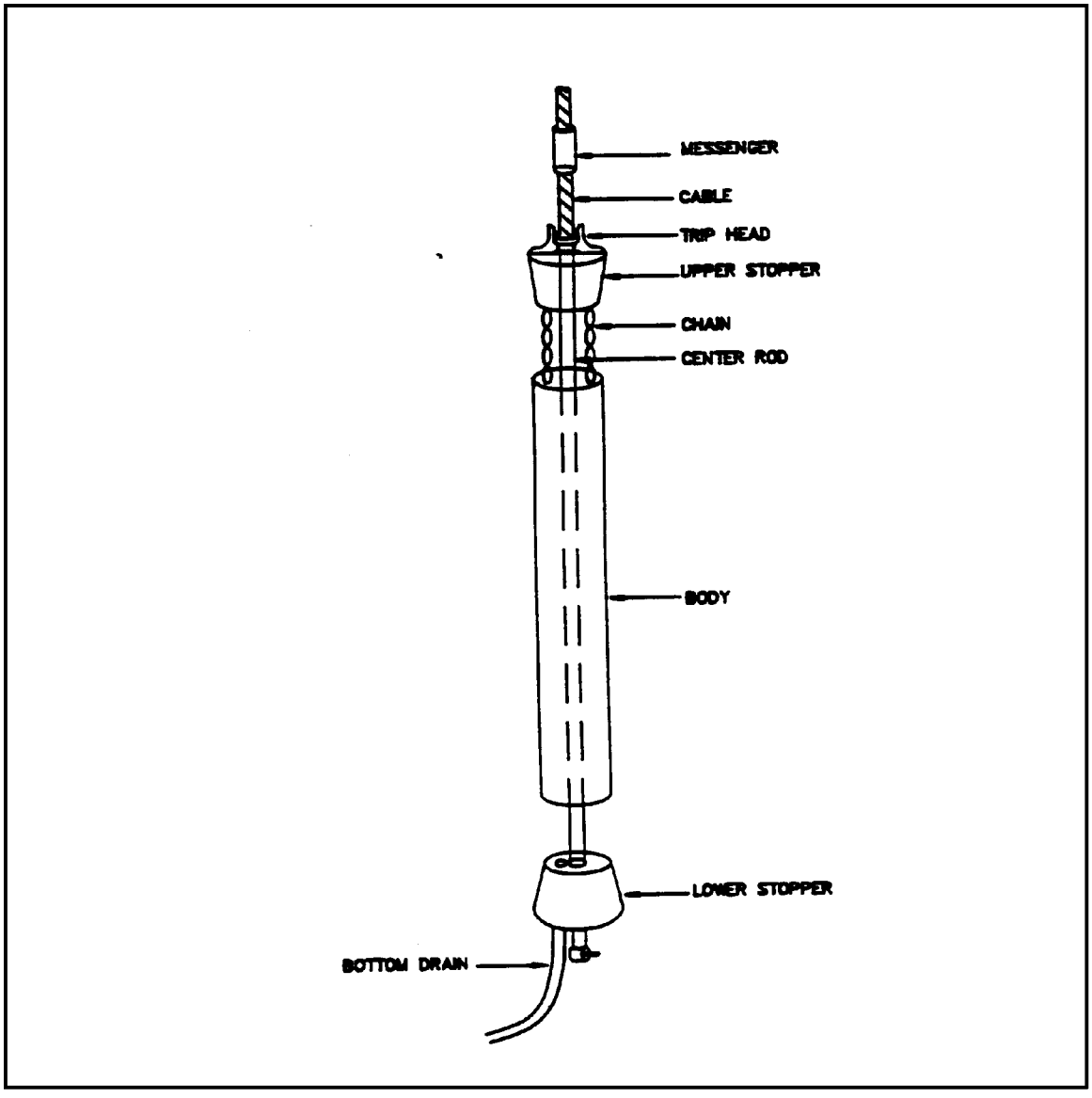
U.S. Geological Survey. 1977. National Handbook or Recommended Methods for Water Data Acquisition. Office of Water Data Coordination Reston, Virginia. (Chapter Updates available).

U.S. Environmental Protection Agency. 1984. Characterization of Hazardous Waste Sites - A Methods Manual: Volume II. Available Sampling Methods, Second Edition. EPA/600/4-84-076.

APPENDIX A

Figures

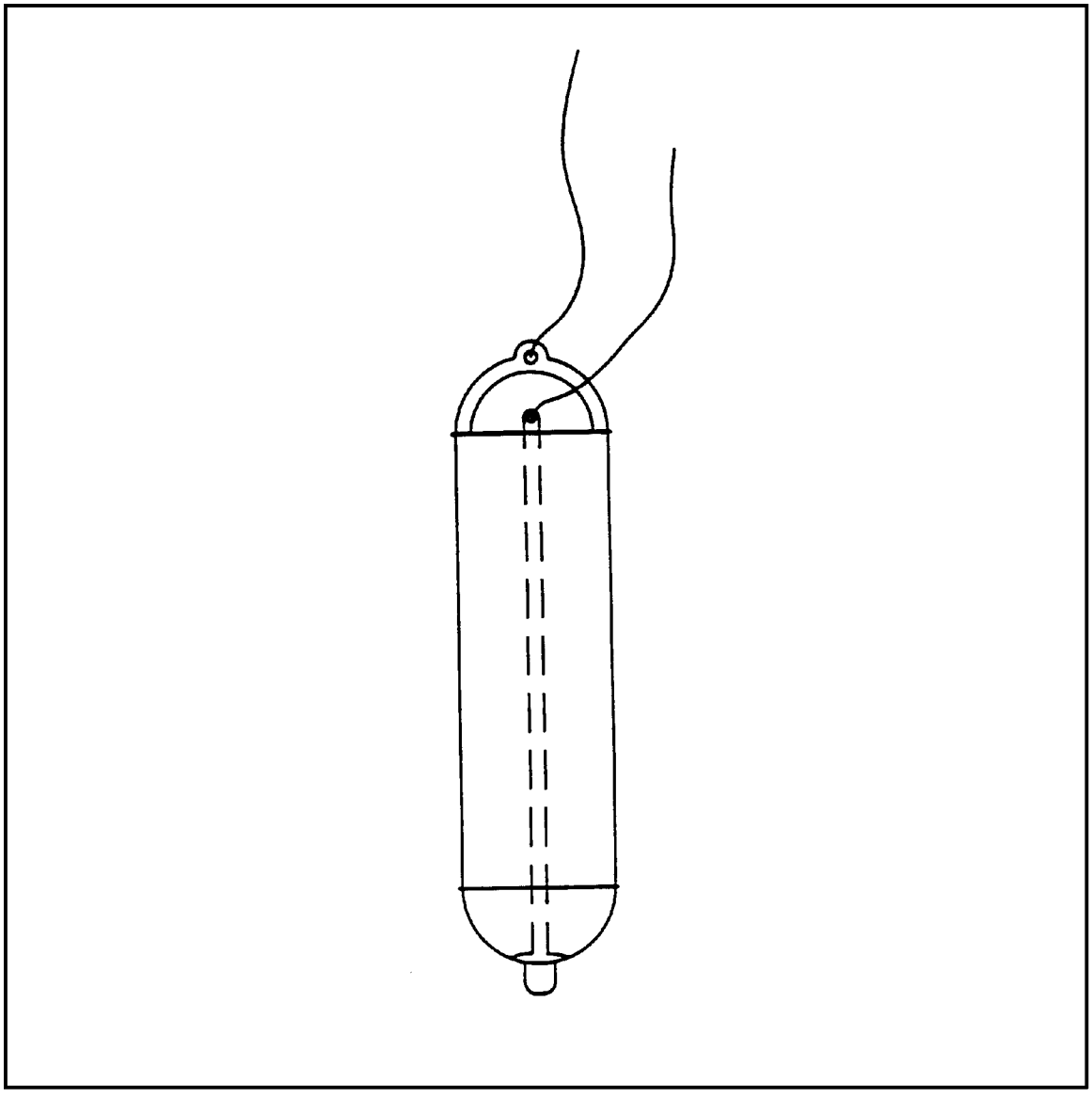
FIGURE 1. Kemmerer Bottle



APPENDIX A (Cont'd)

Figures

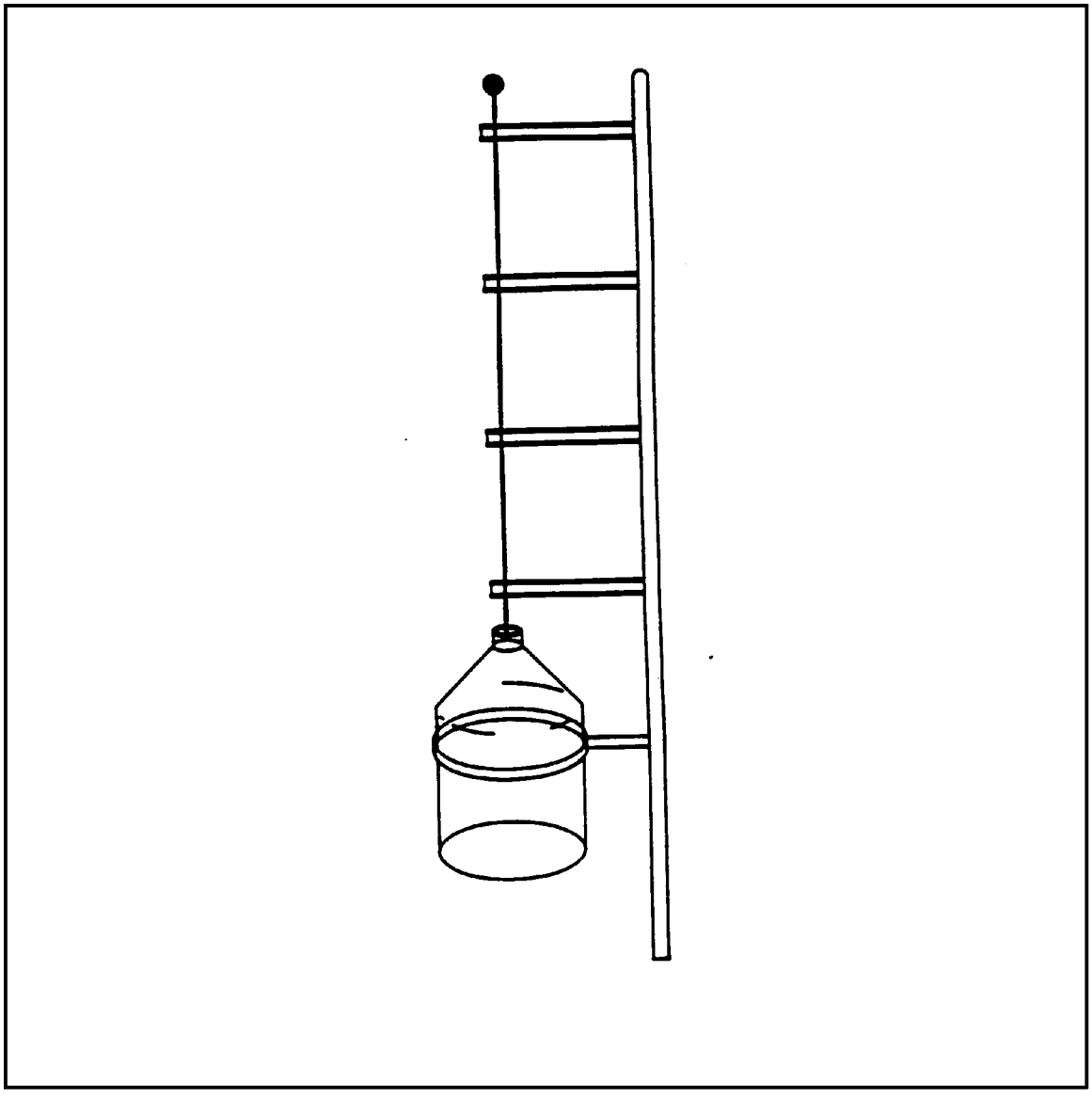
FIGURE 2. Bacon Bomb Sampler



APPENDIX A (Cont'd)

Figures

FIGURE 3. Dip Sampler



SAMPLING EQUIPMENT DECONTAMINATION

SOP#: 2006
DATE: 08/11/94
REV. #: 0.0

1.0 SCOPE AND APPLICATION

The purpose of this Standard Operating Procedure (SOP) is to provide a description of the methods used for preventing, minimizing, or limiting cross-contamination of samples due to inappropriate or inadequate equipment decontamination and to provide general guidelines for developing decontamination procedures for sampling equipment to be used during hazardous waste operations as per 29 Code of Federal Regulations (CFR) 1910.120. This SOP does not address personnel decontamination.

These are standard (i.e. typically applicable) operating procedures which may be varied or changed as required, dependent upon site conditions, equipment limitation, or limitations imposed by the procedure. In all instances, the ultimate procedures employed should be documented and associated with the final report.

Mention of trade names or commercial products does not constitute U.S. Environmental Protection Agency (U.S. EPA) endorsement or recommendation for use.

2.0 METHOD SUMMARY

Removing or neutralizing contaminants from equipment minimizes the likelihood of sample cross contamination, reduces or eliminates transfer of contaminants to clean areas, and prevents the mixing of incompatible substances.

Gross contamination can be removed by physical decontamination procedures. These abrasive and non-abrasive methods include the use of brushes, air and wet blasting, and high and low pressure water cleaning.

The first step, a soap and water wash, removes all visible particulate matter and residual oils and grease. This may be preceded by a steam or high pressure water wash to facilitate residuals removal. The second step involves a tap water rinse and a distilled/deionized water rinse to remove the detergent. An acid rinse provides a low pH media for trace metals removal and is included in the decontamination process if metal samples are to be collected. It is followed by another distilled/deionized water rinse. If sample analysis does not include metals, the acid rinse step can be omitted. Next, a high purity solvent rinse is performed for trace organics removal if organics are a concern at the site. Typical solvents used for removal of organic contaminants include acetone, hexane, or water. Acetone is typically chosen because it is an excellent solvent, miscible in water, and not a target analyte on the Priority Pollutant List. If acetone is known to be a contaminant of concern at a given site or if Target Compound List analysis (which includes acetone) is to be performed, another solvent may be substituted. The solvent must be allowed to evaporate completely and then a final distilled/deionized water rinse is performed. This rinse removes any residual traces of the solvent.

The decontamination procedure described above may be summarized as follows:

1. Physical removal
2. Non-phosphate detergent wash
3. Tap water rinse
4. Distilled/deionized water rinse
5. 10% nitric acid rinse
6. Distilled/deionized water rinse
7. Solvent rinse (pesticide grade)
8. Air dry
9. Distilled/deionized water rinse

If a particular contaminant fraction is not present at the site, the nine (9) step decontamination procedure specified above may be modified for site specificity. For example, the nitric acid rinse may be eliminated if metals are not of concern at a site. Similarly, the solvent rinse may be eliminated if organics are not of

concern at a site. Modifications to the standard procedure should be documented in the site specific work plan or subsequent report.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

The amount of sample to be collected and the proper sample container type (i.e., glass, plastic), chemical preservation, and storage requirements are dependent on the matrix being sampled and the parameter(s) of interest.

More specifically, sample collection and analysis of decontamination waste may be required before beginning proper disposal of decontamination liquids and solids generated at a site. This should be determined prior to initiation of site activities.

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

- The use of distilled/deionized water commonly available from commercial vendors may be acceptable for decontamination of sampling equipment provided that it has been verified by laboratory analysis to be analyte free (specifically for the contaminants of concern).
- The use of an untreated potable water supply is not an acceptable substitute for tap water. Tap water may be used from any municipal or industrial water treatment system.
- If acids or solvents are utilized in decontamination they raise health and safety, and waste disposal concerns.
- Damage can be incurred by acid and solvent washing of complex and sophisticated sampling equipment.

5.0 EQUIPMENT/APPARATUS

Decontamination equipment, materials, and supplies are generally selected based on availability. Other considerations include the ease of decontaminating or disposing of the equipment. Most equipment and supplies can be easily procured. For example, soft-bristle scrub brushes or long-handled bottle brushes can be used to remove contaminants. Large galvanized wash tubs, stock tanks, or buckets can hold wash and rinse solutions. Children's wading pools can also be used. Large plastic garbage cans or other similar containers lined with plastic bags can help segregate contaminated equipment. Contaminated liquid can be stored temporarily in metal or plastic cans or drums.

The following standard materials and equipment are recommended for decontamination activities:

5.1 Decontamination Solutions

- Non-phosphate detergent
- Selected solvents (acetone, hexane, nitric acid, etc.)
- Tap water
- Distilled or deionized water

5.2 Decontamination Tools/Supplies

- Long and short handled brushes
- Bottle brushes
- Drop cloth/plastic sheeting
- Paper towels
- Plastic or galvanized tubs or buckets
- Pressurized sprayers (H_2O)
- Solvent sprayers
- Aluminum foil

5.3 Health and Safety Equipment

Appropriate personal protective equipment (i.e., safety glasses or splash shield, appropriate gloves, aprons or coveralls, respirator, emergency eye wash)

5.4 Waste Disposal

- Trash bags
- Trash containers
- 55-gallon drums
- Metal/plastic buckets/containers for storage and disposal of decontamination solutions

6.0 REAGENTS

There are no reagents used in this procedure aside from the actual decontamination solutions. Table 1 (Appendix A) lists solvent rinses which may be required for elimination of particular chemicals. In

general, the following solvents are typically utilized for decontamination purposes:

- C 10% nitric acid is typically used for inorganic compounds such as metals. An acid rinse may not be required if inorganics are not a contaminant of concern.
- C Acetone (pesticide grade)[1]
- C Hexane (pesticide grade)[1]
- C Methanol[1]

[1] - Only if sample is to be analyzed for organics.

7.0 PROCEDURES

As part of the health and safety plan, a decontamination plan should be developed and reviewed. The decontamination line should be set up before any personnel or equipment enter the areas of potential exposure. The equipment decontamination plan should include:

- C The number, location, and layout of decontamination stations.
- C Decontamination equipment needed.
- C Appropriate decontamination methods.
- C Methods for disposal of contaminated clothing, equipment, and solutions.
- C Procedures can be established to minimize the potential for contamination. This may include: (1) work practices that minimize contact with potential contaminants; (2) using remote sampling techniques; (3) covering monitoring and sampling equipment with plastic, aluminum foil, or other protective material; (4) watering down dusty areas; (5) avoiding laying down equipment in areas of obvious contamination; and (6) use of disposable sampling equipment.

7.1 Decontamination Methods

All samples and equipment leaving the contaminated area of a site must be decontaminated to remove any contamination that may have adhered to equipment. Various decontamination methods will remove contaminants by: (1) flushing or other physical action, or (2) chemical complexing to inactivate contaminants by neutralization, chemical reaction, disinfection, or sterilization.

Physical decontamination techniques can be grouped into two categories: abrasive methods and non-abrasive methods, as follows:

7.1.1 Abrasive Cleaning Methods

Abrasive cleaning methods work by rubbing and wearing away the top layer of the surface containing the contaminant. The mechanical abrasive cleaning methods are most commonly used at hazardous waste sites. The following abrasive methods are available:

Mechanical

Mechanical methods of decontamination include using metal or nylon brushes. The amount and type of contaminants removed will vary with the hardness of bristles, length of time brushed, degree of brush contact, degree of contamination, nature of the surface being cleaned, and degree of contaminant adherence to the surface.

Air Blasting

Air blasting equipment uses compressed air to force abrasive material through a nozzle at high velocities. The distance between nozzle and surface cleaned, air pressure, time of application, and angle at which the abrasive strikes the surface will dictate cleaning efficiency. Disadvantages of this method are the inability to control the amount of material removed and the large amount of waste generated.

Wet Blasting

Wet blast cleaning involves use of a suspended fine abrasive. The abrasive/water mixture is delivered by compressed air to the contaminated area. By using a very fine abrasive, the amount of materials removed can be carefully controlled.

7.1.2 Non-Abrasive Cleaning Methods

Non-abrasive cleaning methods work by forcing the contaminant off a surface with pressure. In general, the equipment surface is not removed using non-abrasive methods.

Low-Pressure Water

This method consists of a container which is filled with water. The user pumps air out of the container to create a vacuum. A slender nozzle and hose allow the user to spray in hard-to-reach places.

High-Pressure Water

This method consists of a high-pressure pump, an operator controlled directional nozzle, and a high-pressure hose. Operating pressure usually ranges from 340 to 680 atmospheres (atm) and flow rates usually range from 20 to 140 liters per minute.

Ultra-High-Pressure Water

This system produces a water jet that is pressured from 1,000 to 4,000 atmospheres. This ultra-high-pressure spray can remove tightly-adhered surface films. The water velocity ranges from 500 meters/second (m/s) (1,000 atm) to 900 m/s (4,000 atm). Additives can be used to enhance the cleaning action.

Rinsing

Contaminants are removed by rinsing through dilution, physical attraction, and solubilization.

Damp Cloth Removal

In some instances, due to sensitive, non-waterproof equipment or due to the unlikelihood of equipment being contaminated, it is not necessary to conduct an extensive decontamination procedure. For example, air sampling pumps hooked on a fence, placed on a drum, or wrapped in plastic bags are not likely to become heavily contaminated. A damp cloth should be used to wipe off contaminants which may have adhered to equipment through airborne contaminants or from surfaces upon which the equipment was set.

Disinfection/Sterilization

Disinfectants are a practical means of inactivating infectious agents. Unfortunately, standard sterilization methods are impractical for large equipment. This method of decontamination is typically performed off-site.

7.2 Field Sampling Equipment Decontamination Procedures

The decontamination line is setup so that the first station is used to clean the most contaminated item. It progresses to the last station where the least contaminated item is cleaned. The spread of contaminants is further reduced by separating each decontamination station by a minimum of three (3) feet. Ideally, the contamination should decrease as the equipment progresses from one station to another farther along in the line.

A site is typically divided up into the following boundaries: Hot Zone or Exclusion Zone (EZ), the Contamination Reduction Zone (CRZ), and the Support or Safe Zone (SZ). The decontamination line should be setup in the Contamination Reduction Corridor (CRC) which is in the CRZ. Figure 1 (Appendix B) shows a typical contaminant reduction zone layout. The CRC controls access into and out of the exclusion zone and confines decontamination activities to a limited area. The CRC boundaries should be conspicuously marked. The far end is the hotline, the boundary between the exclusion zone and the contamination reduction zone. The size of the decontamination corridor depends on the number of stations in the decontamination process, overall dimensions of the work zones, and amount of space available at the site. Whenever possible, it should be a straight line.

Anyone in the CRC should be wearing the level of protection designated for the decontamination crew. Another corridor may be required for the entry and exit of heavy equipment. Sampling and monitoring equipment and sampling supplies are all maintained outside of the CRC. Personnel don their equipment away from the CRC and enter the exclusion zone through a separate access control point at the hotline. One person (or more) dedicated to decontaminating equipment is recommended.

7.2.1 Decontamination Setup

Starting with the most contaminated station, the decontamination setup should be as follows:

Station 1: Segregate Equipment Drop

Place plastic sheeting on the ground (Figure 2, Appendix B). Size will depend on amount of

equipment to be decontaminated. Provide containers lined with plastic if equipment is to be segregated. Segregation may be required if sensitive equipment or mildly contaminated equipment is used at the same time as equipment which is likely to be heavily contaminated.

Station 2: Physical Removal With A High-Pressure Washer (Optional)

As indicated in 7.1.2, a high-pressure wash may be required for compounds which are difficult to remove by washing with brushes. The elevated temperature of the water from the high-pressure washers is excellent at removing greasy/oily compounds. High pressure washers require water and electricity.

A decontamination pad may be required for the high-pressure wash area. An example of a wash pad may consist of an approximately 1 1/2 foot-deep basin lined with plastic sheeting and sloped to a sump at one corner. A layer of sand can be placed over the plastic and the basin is filled with gravel or shell. The sump is also lined with visqueen and a barrel is placed in the hole to prevent collapse. A sump pump is used to remove the water from the sump for transfer into a drum.

Typically heavy machinery is decontaminated at the end of the day unless site sampling requires that the machinery be decontaminated frequently. A separate decontamination pad may be required for heavy equipment.

Station 3: Physical Removal With Brushes And A Wash Basin

Prior to setting up Station 3, place plastic sheeting on the ground to cover areas under Station 3 through Station 10.
Fill a wash basin, a large bucket, or child's swimming pool with non-phosphate detergent and tap water. Several bottle and bristle brushes to physically remove contamination should be dedicated to this station. Approximately 10 - 50 gallons of water may be required initially depending upon the amount of equipment to decontaminate and the amount of gross contamination.

Station 4: Water Basin

Fill a wash basin, a large bucket, or child's swimming pool with tap water. Several bottle and bristle brushes should be dedicated to this station. Approximately 10-50 gallons of water may be required initially depending upon the amount of equipment to decontaminate and the amount of gross contamination.

Station 5: Low-Pressure Sprayers

Fill a low-pressure sprayer with distilled/deionized water. Provide a 5-gallon bucket or basin to contain the water during the rinsing process. Approximately 10-20 gallons of water may be required initially depending upon the amount of equipment to decontaminate and the amount of gross contamination.

Station 6: Nitric Acid Sprayers

Fill a spray bottle with 10% nitric acid. An acid rinse may not be required if inorganics are not a contaminant of concern. The amount of acid will depend on the amount of equipment to be decontaminated. Provide a 5-gallon bucket or basin to collect acid during the rinsing process.

Station 7: Low-Pressure Sprayers

Fill a low-pressure sprayer with distilled/deionized water. Provide a 5-gallon bucket or basin to collect water during the rinsate process.

Station 8: Organic Solvent Sprayers

Fill a spray bottle with an organic solvent. After each solvent rinse, the equipment should be rinsed with distilled/deionized water and air dried. Amount of solvent will depend on the amount of equipment to decontaminate. Provide a 5-gallon bucket or basin to collect the solvent during the rinsing process.

Solvent rinses may not be required unless organics are a contaminant of concern, and may be eliminated from the station sequence.

Station 9: Low-Pressure Sprayers

Fill a low-pressure sprayer with distilled/deionized water. Provide a 5-gallon bucket or basin to collect water during the rinsate process.

Station 10: Clean Equipment Drop

Lay a clean piece of plastic sheeting over the bottom

plastic layer. This will allow easy removal of the plastic in the event that it becomes dirty. Provide aluminum foil, plastic, or other protective material to wrap clean equipment.

7.2.2 Decontamination Procedures

Station 1: Segregate Equipment Drop

Deposit equipment used on-site (i.e., tools, sampling devices and containers, monitoring instruments radios, clipboards, etc.) on the plastic drop cloth/sheet or in different containers with plastic liners. Each will be contaminated to a different degree. Segregation at the drop reduces the probability of cross contamination. Loose leaf sampling data sheets or maps can be placed in plastic zip lock bags if contamination is evident.

Station 2: Physical Removal With A High-Pressure Washer (Optional)

Use high pressure wash on grossly contaminated equipment. Do not use high- pressure wash on sensitive or non-waterproof equipment.

Station 3: Physical Removal With Brushes And A Wash Basin

Scrub equipment with soap and water using bottle and bristle brushes. Only sensitive equipment (i.e., radios, air monitoring and sampling equipment) which is waterproof should be washed. Equipment which is not waterproof should have plastic bags removed and wiped down with a damp cloth. Acids and organic rinses may also ruin sensitive equipment. Consult the manufacturers for recommended decontamination solutions.

Station 4: Equipment Rinse

Wash soap off of equipment with water by immersing the equipment in the water while brushing. Repeat as many times as necessary.

Station 5: Low-Pressure Rinse

Rinse sampling equipment with distilled/deionized water with a low-pressure sprayer.

Station 6: Nitric Acid Sprayers (required only if metals are a contaminant of concern)

Using a spray bottle rinse sampling equipment with nitric acid. Begin spraying (inside and outside) at one end of the equipment allowing the acid to drip to the other end into a 5-gallon bucket. A rinsate blank may be required at this station. Refer to Section 9.

Station 7: Low-Pressure Sprayers

Rinse sampling equipment with distilled/deionized water with a low-pressure sprayer.

Station 8: Organic Solvent Sprayers

Rinse sampling equipment with a solvent. Begin spraying (inside and outside) at one end of the equipment allowing the solvent to drip to the other end into a 5-gallon bucket. Allow the solvent to evaporate from the equipment before going to the next station. A QC rinsate sample may be required at this station.

Station 9: Low-Pressure Sprayers

Rinse sampling equipment with distilled/deionized water with a low-pressure washer.

Station 10 : Clean Equipment Drop

Lay clean equipment on plastic sheeting. Once air dried, wrap sampling equipment with aluminum foil, plastic, or other protective material.

7.2.3 Post Decontamination Procedures

1. Collect high-pressure pad and heavy equipment decontamination area liquid and waste and store in appropriate drum or container. A sump pump can aid in the collection process. Refer to the Department of Transportation (DOT) requirements for appropriate containers based on the contaminant of concern.

2. Collect high-pressure pad and heavy equipment decontamination area solid waste and store in appropriate drum or container. Refer to the DOT requirements for appropriate containers based on the contaminant of concern.

3. Empty soap and water liquid wastes from basins and buckets and store in appropriate

drum or container. Refer to the DOT requirements for appropriate containers based on the contaminant of concern.

4. Empty acid rinse waste and place in appropriate container or neutralize with a base and place in appropriate drum. pH paper or an equivalent pH test is required for neutralization. Consult DOT requirements for appropriate drum for acid rinse waste.

5. Empty solvent rinse sprayer and solvent waste into an appropriate container. Consult DOT requirements for appropriate drum for solvent rinse waste.

6. Using low-pressure sprayers, rinse basins, and brushes. Place liquid generated from this process into the wash water rinse container.

7. Empty low-pressure sprayer water onto the ground.

8. Place all solid waste materials generated from the decontamination area (i.e., gloves and plastic sheeting, etc.) in an approved DOT drum. Refer to the DOT requirements for appropriate containers based on the contaminant of concern.

9. Write appropriate labels for waste and make arrangements for disposal. Consult DOT regulations for the appropriate label for each drum generated from the decontamination process.

8.0 CALCULATIONS

This section is not applicable to this SOP.

9.0 QUALITYASSURANCE/ QUALITY CONTROL

A rinsate blank is one specific type of quality control sample associated with the field decontamination process. This sample will provide information on the effectiveness of the decontamination process employed in the field.

Rinsate blanks are samples obtained by running analyte free water over decontaminated sampling equipment to test for residual contamination. The blank water is collected in sample containers for handling, shipment, and analysis. These samples are treated identical to samples collected that day. A rinsate blank is used to assess cross contamination brought about by improper decontamination procedures. Where dedicated sampling equipment is not utilized, collect one rinsate blank per day per type of sampling device samples to meet QA2 and QA3 objectives.

If sampling equipment requires the use of plastic tubing it should be disposed of as contaminated and replaced with clean tubing before additional sampling occurs.

10.0 DATA VALIDATION

Results of quality control samples will be evaluated for contamination. This information will be utilized to qualify the environmental sample results in accordance with the project's data quality objectives.

11.0 HEALTH AND SAFETY

When working with potentially hazardous materials, follow OSHA, U.S. EPA, corporate, and other applicable health and safety procedures.

Decontamination can pose hazards under certain circumstances. Hazardous substances may be incompatible with decontamination materials. For example, the decontamination solution may react with contaminants to produce heat, explosion, or toxic products. Also, vapors from decontamination solutions may pose a direct health hazard to workers by inhalation, contact, fire, or explosion.

The decontamination solutions must be determined to be acceptable before use. Decontamination materials may degrade protective clothing or equipment; some solvents can permeate protective clothing. If decontamination materials do pose a health hazard, measures should be taken to protect personnel or substitutions should be made to eliminate the hazard. The choice of respiratory protection based on contaminants of concern from the site may not be appropriate for solvents used in the decontamination process.

Safety considerations should be addressed when using abrasive and non-abrasive decontamination

equipment. Maximum air pressure produced by abrasive equipment could cause physical injury. Displaced material requires control mechanisms.

Material generated from decontamination activities requires proper handling, storage, and disposal. Personal Protective Equipment may be required for these activities.

Material safety data sheets are required for all decontamination solvents or solutions as required by the Hazard Communication Standard (i.e., acetone, alcohol, and trisodiumphosphate).

In some jurisdictions, phosphate containing detergents (i.e., TSP) are banned.

12.0 REFERENCES

Field Sampling Procedures Manual, New Jersey Department of Environmental Protection, February, 1988.

A Compendium of Superfund Field Operations Methods, EPA 540/p-87/001.

Engineering Support Branch Standard Operating Procedures and Quality Assurance Manual, USEPA Region IV, April 1, 1986.

Guidelines for the Selection of Chemical Protective Clothing, Volume 1, Third Edition, American Conference of Governmental Industrial Hygienists, Inc., February, 1987.

Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities, NIOSH/OSHA/USCG/EPA, October, 1985.

APPENDIX A

Table

Table 1. Soluble Contaminants and Recommended Solvent Rinse

TABLE 1 Soluble Contaminants and Recommended Solvent Rinse		
SOLVENT[1]	EXAMPLES OF SOLVENTS	SOLUBLE CONTAMINANTS
Water	Deionized water Tap water	Low-chain hydrocarbons Inorganic compounds Salts Some organic acids and other polar compounds
Dilute Acids	Nitric acid Acetic acid Boric acid	Basic (caustic) compounds (e.g., amines and hydrazines)
Dilute Bases	Sodium bicarbonate (e.g., soap detergent)	Acidic compounds Phenol Thiols Some nitro and sulfonic compounds
Organic Solvents [2]	Alcohols Ethers Ketones Aromatics Straight chain alkalines (e.g., hexane) Common petroleum products (e.g., fuel, oil, kerosene)	Nonpolar compounds (e.g., some organic compounds)
Organic Solvent[2]	Hexane	PCBs

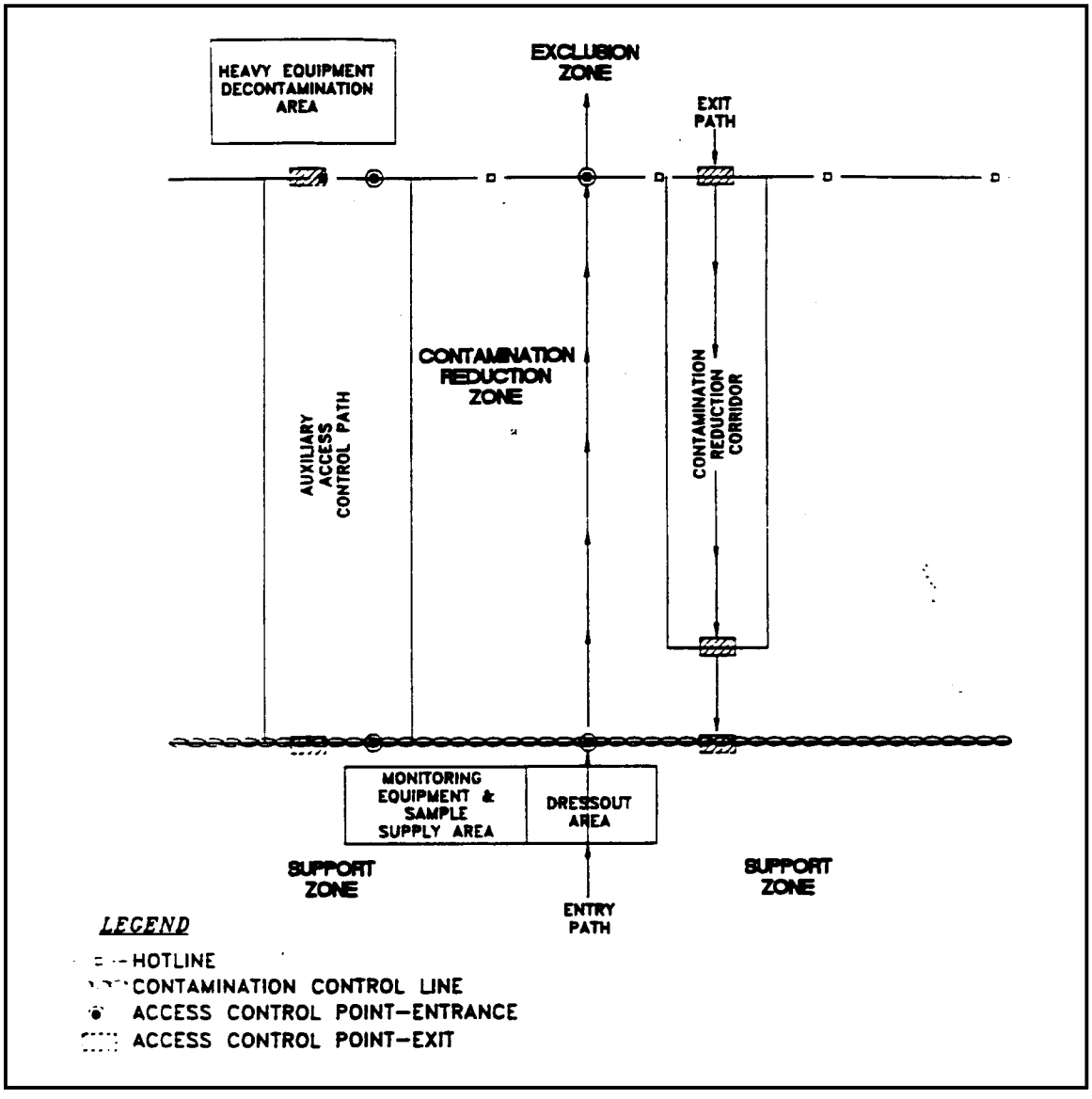
[1] - Material safety data sheets are required for all decontamination solvents or solutions as required by the Hazard Communication Standard

[2] - WARNING: Some organic solvents can permeate and/or degrade the protective clothing

APPENDIX B

Figures

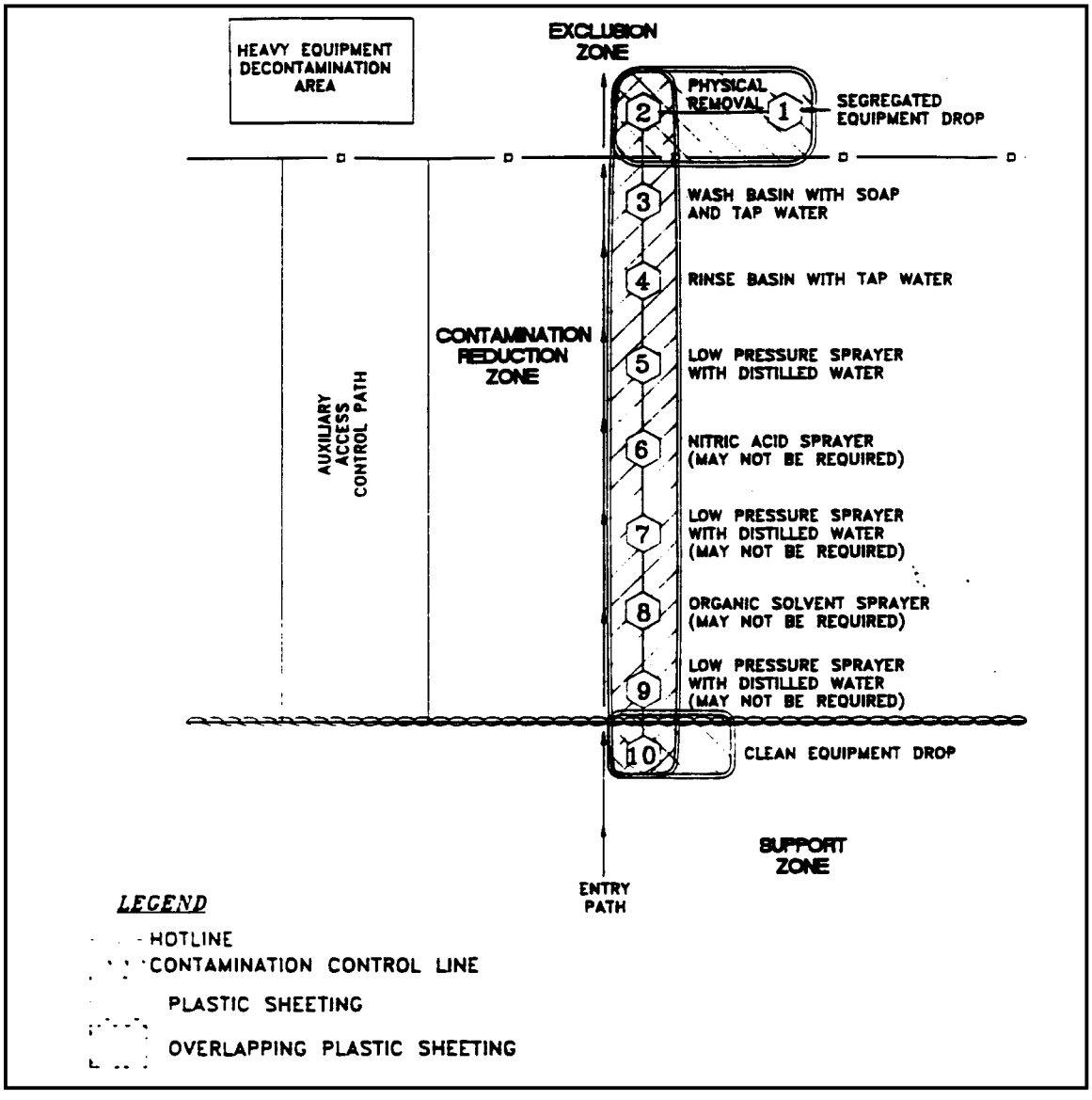
Figure 1. Contamination Reduction Zone Layout



APPENDIX B (Cont'd.)

Figures

Figure 2. Decontamination Layout



GENERAL FIELD SAMPLING GUIDELINES

SOP#: 2001
DATE: 08/11/94
REV. #: 0.0

1.0 SCOPE AND APPLICATION

The purpose of this Standard Operating Procedure (SOP) is to provide general field sampling guidelines that will assist REAC personnel in choosing sampling strategies, location, and frequency for proper assessment of site characteristics. This SOP is applicable to all field activities that involve sampling.

These are standard (i.e., typically applicable) operating procedures which may be varied or changed as required, dependent on site conditions, equipment limitations or limitations imposed by the procedure. In all instances, the ultimate procedures employed should be documented and associated with the final report.

Mention of trade names or commercial products does not constitute U.S. EPA endorsement or recommendation for use.

2.0 METHOD SUMMARY

Sampling is the selection of a representative portion of a larger population, universe, or body. Through examination of a sample, the characteristics of the larger body from which the sample was drawn can be inferred. In this manner, sampling can be a valuable tool for determining the presence, type, and extent of contamination by hazardous substances in the environment.

The primary objective of all sampling activities is to characterize a hazardous waste site accurately so that its impact on human health and the environment can be properly evaluated. It is only through sampling and analysis that site hazards can be measured and the job of cleanup and restoration can be accomplished effectively with minimal risk. The sampling itself must be conducted so that every sample collected retains its original physical form and chemical composition. In this way, sample integrity is insured, quality assurance standards are maintained, and the sample can accurately represent the larger body of material under investigation.

The extent to which valid inferences can be drawn from a sample depends on the degree to which the sampling effort conforms to the project's objectives. For example, as few as one sample may produce adequate, technically valid data to address the project's objectives. Meeting the project's objectives requires thorough planning of sampling activities, and implementation of the most appropriate sampling and analytical procedures. These issues will be discussed in this procedure.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

The amount of sample to be collected, and the proper sample container type (i.e., glass, plastic), chemical preservation, and storage requirements are dependent on the matrix being sampled and the parameter(s) of interest. Sample preservation, containers, handling, and storage for air and waste samples are discussed in the specific SOPs for air and waste sampling techniques.

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

The nature of the object or materials being sampled may be a potential problem to the sampler. If a material is homogeneous, it will generally have a uniform composition throughout. In this case, any sample increment can be considered representative of the material. On the other hand, heterogeneous samples present problems to the sampler because of changes in the material over distance, both laterally and vertically.

Samples of hazardous materials may pose a safety threat to both field and laboratory personnel. Proper health and safety precautions should be implemented when handling this type of sample.

Environmental conditions, weather conditions, or non-target chemicals may cause problems and/or interferences when performing sampling activities or when sampling for a specific parameter. Refer to the specific SOPs for sampling techniques.

5.0 EQUIPMENT/APPARATUS

The equipment/apparatus required to collect samples must be determined on a site specific basis. Due to the wide variety of sampling equipment available, refer to the specific SOPs for sampling techniques which include lists of the equipment/apparatus required for sampling.

6.0 REAGENTS

Reagents may be utilized for preservation of samples and for decontamination of sampling equipment. The preservatives required are specified by the analysis to be performed. Decontamination solutions are specified in ERT SOP #2006, Sampling Equipment Decontamination.

7.0 PROCEDURE

7.1 Types of Samples

In relation to the media to be sampled, two basic types of samples can be considered: the environmental sample and the hazardous sample.

Environmental samples are those collected from streams, ponds, lakes, wells, and are off-site samples that are not expected to be contaminated with hazardous materials. They usually do not require the special handling procedures typically used for concentrated wastes. However, in certain instances, environmental samples can contain elevated concentrations of pollutants and in such cases would have to be handled as hazardous samples.

Hazardous or concentrated samples are those collected from drums, tanks, lagoons, pits, waste piles, fresh spills, or areas previously identified as contaminated, and require special handling procedures because of their potential toxicity or hazard. These samples can be further subdivided based on their degree of hazard; however, care should be taken when handling and shipping any wastes believed to be concentrated regardless of the degree.

The importance of making the distinction between environmental and hazardous samples is two-fold:

(1) Personnel safety requirements: Any sample thought to contain enough hazardous materials to pose a safety threat should be designated as hazardous and handled in a manner which ensures the safety of both field and laboratory personnel.

(2) Transportation requirements: Hazardous samples must be packaged, labeled, and shipped according to the International Air Transport Association (IATA) Dangerous Goods Regulations or Department of Transportation (DOT) regulations and U.S. EPA guidelines.

7.2 Sample Collection Techniques

In general, two basic types of sample collection techniques are recognized, both of which can be used for either environmental or hazardous samples.

Grab Samples

A grab sample is defined as a discrete aliquot representative of a specific location at a given point in time. The sample is collected all at once at one particular point in the sample medium. The representativeness of such samples is defined by the nature of the materials being sampled. In general, as sources vary over time and distance, the representativeness of grab samples will decrease.

Composite Samples

Composites are nondiscrete samples composed of more than one specific aliquot collected at various sampling locations and/or different points in time. Analysis of this type of sample produces an average value and can in certain instances be used as an alternative to analyzing a number of individual grab samples and calculating an average value. It should be noted, however, that compositing can mask problems by diluting isolated concentrations of some hazardous compounds below detection limits.

Compositing is often used for environmental samples and may be used for hazardous samples under certain conditions. For example, compositing of hazardous waste is often performed after compatibility tests have

been completed to determine an average value over a number of different locations (group of drums). This procedure generates data that can be useful by providing an average concentration within a number of units, can serve to keep analytical costs down, and can provide information useful to transporters and waste disposal operations.

For sampling situations involving hazardous wastes, grab sampling techniques are generally preferred because grab sampling minimizes the amount of time sampling personnel must be in contact with the wastes, reduces risks associated with compositing unknowns, and eliminates chemical changes that might occur due to compositing.

7.3 Types of Sampling Strategies

The number of samples that should be collected and analyzed depends on the objective of the investigation. There are three basic sampling strategies: random, systematic, and judgmental sampling.

Random sampling involves collection of samples in a nonsystematic fashion from the entire site or a specific portion of a site. Systematic sampling involves collection of samples based on a grid or a pattern which has been previously established. When judgmental sampling is performed, samples are collected only from the portion(s) of the site most likely to be contaminated. Often, a combination of these strategies is the best approach depending on the type of the suspected/known contamination, the uniformity and size of the site, the level/type of information desired, etc.

7.4 QA Work Plans (QAWP)

A QAWP is required when it becomes evident that a field investigation is necessary. It should be initiated in conjunction with, or immediately following, notification of the field investigation. This plan should be clear and concise and should detail the following basic components, with regard to sampling activities:

- Objective and purpose of the investigation.
- Basis upon which data will be evaluated.
- Information known about the site including location, type and size of the facility, and length of operations/abandonment.
- Type and volume of contaminated material, contaminants of concern (including concentration), and basis of the information/data.
- Technical approach including media/matrix to be sampled, sampling equipment to be used, sample equipment decontamination (if necessary), sampling design and rationale, and SOPs or description of the procedure to be implemented.
- Project management and reporting, schedule, project organization and responsibilities, manpower and cost projections, and required deliverables.
- QA objectives and protocols including tables summarizing field sampling and QA/QC analysis and objectives.

Note that this list of QAWP components is not all-inclusive and that additional elements may be added or altered depending on the specific requirements of the field investigation. It should also be recognized that although a detailed QAWP is quite important, it may be impractical in some instances. Emergency responses and accidental spills are prime examples of such instances where time might prohibit the development of site-specific QAWPs prior to field activities. In such cases, investigators would have to rely on general guidelines and personal judgment, and the sampling or response plans might simply be a strategy based on preliminary information and finalized on site. In any event, a plan of action should be developed, no matter how concise or informal, to aid investigators in maintaining a logical and consistent order to the implementation of their task.

7.5 Legal Implications

The data derived from sampling activities are often introduced as critical evidence during litigation of a hazardous waste site cleanup. Legal issues in which sampling data are important may include cleanup cost recovery, identification of pollution sources and responsible parties, and technical validation of remedial design methodologies. Because of the potential for involvement in legal actions, strict adherence to technical and administrative SOPs is essential during both the development and implementation of sampling activities.

Technically valid sampling begins with thorough planning and continues through the sample collection and analytical procedures. Administrative requirements involve thorough, accurate

documentation of all sampling activities. Documentation requirements include maintenance of a chain of custody, as well as accurate records of field activities and analytical instructions. Failure to observe these procedures fully and consistently may result in data that are questionable, invalid and non-defensible in court, and the consequent loss of enforcement proceedings.

8.0 CALCULATIONS

Refer to the specific SOPs for any calculations which are associated with sampling techniques.

9.0 QUALITY ASSURANCE/ QUALITY CONTROL

Refer to the specific SOPs for the type and frequency of QA/QC samples to be analyzed, the acceptance criteria for the QA/QC samples, and any other QA/QC activities which are associated with sampling techniques.

10.0 DATA VALIDATION

Refer to the specific SOPs for data validation activities that are associated with sampling techniques.

11.0 HEALTH AND SAFETY

When working with potentially hazardous materials, follow U.S. EPA, OSHA, and corporate health and safety procedures.

Appendix C

Bulkhead Plans and Specifications

Red and Bonita Mine Bulkhead Construction Requirements and Specifications

Prepared for the United States Environmental Protection Agency
by
The Colorado Division of Reclamation, Mining and Safety
Inactive Mine Reclamation Program

PROJECT LOCATION

The Red and Bonita Mine is located on the east side and approximately 200 vertical feet above Cement Creek, ten miles north of Silverton, in San Juan County, Colorado (Figure 1). The site is accessed from Silverton via County Road 110, north 6.4 miles to County Road 52, then County Road 52 northbound along the east side of Cement Creek to the Red and Bonita Mine.

WORK SUMMARY

The project work will involve construction of a hydraulic bulkhead in the Red and Bonita adit. Bulkhead construction will consist of ventilation of the working area of the mine to minimum 19.5 percent oxygen at all times (vent bag has been installed to the bulkhead location), mucking out sections of the adit, coffer dam construction, bypass pipe installation, cleaning and scaling at the bulkhead location, inner and outer bulkhead form construction, placement of concrete in formwork, and bulkhead contact grouting after the concrete has cured. The PROJECT MANAGER, as that terms is used in this document, shall be the U.S. Environmental Protection Agency On Scene Coordinator, or the On Scene Coordinator's designee.

PROJECT WORK DESCRIPTION

ITEM 1.0: PREPARE BULKHEAD LOCATION AND BYPASS PIPE

Preparation of the Bulkhead Location includes construction of the upstream cofferdams, installation of the bypass pipe, and cleanup, scaling and preparation of the bulkhead location, all in accordance with these specifications, and drawings as follows:

- Plate 1. Longitudinal Cross Section of Forms, Steel Beam Supports and Contact Grout Holes,
- Plate 2. Plan View of Bulkhead Forms with Steel Beam Supports,
- Plate 3. Air Side Form Face,
- Plate 4. Air Side #9 Rebar Cage Plus Contact Grout Holes

Muck working areas of Red and Bonita Mine

The first 300 feet of the main Red and Bonita crosscut heading and the first 25 feet of the 275-drift must be mucked-out (Figure 2). The floor of the mine has accumulated metal hydroxide precipitates and silt deposits to a thickness of up to three feet. The CONTRACTOR will muck these deposits into the 300-plus gallon per minute mine discharge such that the deposits will flow out of the mine as a slurry, which will be routed to a water treatment system and retention ponds that will be operated by others. The CONTRACTOR must coordinate mucking operations with the operator of the water treatment system such that the system is not overwhelmed and the discharge from the ponds is adequately clarified as determined by the PROJECT MANAGER.

Install Injection Pipe

The CONTRACTOR will provide and install a 3/4-in. Schedule 80 PVC or HDPE injection pipe from the upstream end of the bulkhead to easternmost safely accessible location in the north the Red and Bonita Mine shown on Figure 2. The heading of injection pipe will have threaded connections and will be carried by hangers spaced every ten-feet installed in the back (roof) of the adit. The hangers will be installed into holes drilled into the mine roof and secured with epoxy or compression fittings. The injection pipe will be clamped to the hangers. At the bulkhead location, a stainless steel "Y" connection will be threaded to the injection pipe and will eventually be threaded to the 3/4-in. Schedule 80 water sampling and pressure measurement stainless steel pipe shown on the Plates. The other port on the "Y" connector will be fitted with a stainless steel check valve rated to 600 psi minimum that will prevent backflow through the check valve during fluid injection operations and force injected fluid into the injection pipe. When injection is not occurring, the check valve will remain open to allow pressure reading and water sampling of the mine pool at the water side of the bulkhead. Approximately 700-feet of injection pipe will be required, with sufficient hangers, clamps, angles and fittings to route the pipe to the east end of the adit.

Construct Two Upstream Cofferdams

The upstream end of the bulkhead will be sited as close to the intersection of the main crosscut heading and the 275-drift as possible. Construct upstream concrete or plastic sheeting covered sandbag cofferdams in the main crosscut beyond Station 2+75, and in the 275-drift, at locations chosen by the CONTRACTOR. The cofferdams will have a height at least 3-ft. above the existing adit floor. Water passing under, around or through the cofferdams must be eliminated in order to facilitate construction and concrete filling of the bulkhead form. Include a 8-in. nominal inside diameter, Schedule 40, type 316-stainless steel bypass pipe penetration through the cofferdam centered approximately 1-ft. 6-in. above the tunnel rock invert (floor), a minimum of 1-ft. 6-in. below the top of the cofferdam, and extending at least 1-ft. into the upstream pond. The pipe inlet will be protected from blockage by a fully-enclosed screened metal trash rack or perforated plastic pipe connected to the bypass pipe that rises at least 2-ft. above the top of the cofferdam.

Install Bypass Pipe

The entire length of the construction bypass pipe from cofferdam inlets to the downstream outlet shall be completed using flanged connections throughout, before starting construction of the bulkhead forms. A "Y" connector will be required to combine the pipes from each coffer dam into a single pipe through the bulkhead location. Clearing the broken rock ballast below the bypass pipe alignment through the bulkhead construction area is required so that the entire length of, 8-in. nominal inside diameter (ID), Schedule 40, type 316-stainless steel pipe, stainless steel fittings and fixtures through the bulkhead and the 8-in. stainless steel gate valve can be supported from solid rock at approximately 5-ft. intervals along the pipe. Steel rebar chairs or solid concrete blocks are to be utilized for pipe support within the bulkhead and stabilized by wire ties to resin anchored eyebolts embedded approximately 1-ft. into the floor and adjacent rib. All bypass pipe tie-downs must be able to resist uplift force generated during concrete placement in bulkhead forms. If the pipe supports or wire ties within the bulkhead are disturbed during construction of the bulkhead forms they shall be reinstalled before the final bulkhead form inspection and filling.

A temporary 8-in. diameter steel, wrought iron, HDPE or other downstream (air side) water diversion pipe must be completed, connected and functioning to bypass the flow of acid mine drainage before starting work on the bulkhead forms. See plans and sections noted above. The

length of the water diversion tail-pipe must extend to a discharge location outside the adit portal selected by the PROJECT MANAGER. The permanent connection between the stainless steel pipe and gate valve shall include Teflon tape, or other thread sealant.

The 8-in. stainless steel pipe through the bulkhead will include two (2) 14.5-in. by 14.5-in. square, 1/2-in. thick stainless steel thrust plate/water-stops that have been continuously fillet welded, on both sides of the plates, around the bypass pipe 4-ft. and 11-ft. inside the bulkhead from the water side (upstream) bulkhead form. The 8-in. stainless steel gate valve should be centered approximately 2-ft. from the air side (downstream) face of the concrete bulkhead.

Prepare Rock Surfaces in Bulkhead Location

Scale loose rock from the roof and walls, exposing fresh, clean and sound rock. The mine rails, if present and all broken rock ballast and ties will be removed from the floor in the bulkhead construction area, in the vicinity of Station 2+75. Solid rock will be exposed by scaling, prying up loose rock, and washing the floor and ribs clean to permit measuring the maximum tunnel height and width through the length of the bulkhead location. Four drill holes into the ribs of the adit (2-in. diameter, 12-feet long) must be grouted full with Type V neat cement grout at a minimum pressure of 90 psi.

Bulkhead Surface-Profiling

After scaling and washing are completed and loose rock, ballast, ties, and rail are removed, the bulkhead area will be inspected, measured and profiled in reference to tunnel centerline on 0.5 -ft. stationing. The profiling is to verify that the bulkhead design parameters remain valid, and to verify measurement for payment of Concrete placement. The rock surface irregularity along a parallel marked string-line shall be profiled along each tunnel rib, the back (roof) and the floor on 0.5 -ft. stationing. The PROJECT MANAGER shall inspect the rock surfaces for geologic structures and weaknesses that could compromise the design. A copy of the completed bulkhead surface profile shall be provided to the PROJECT MANAGER.

ITEM 2.0: CONSTRUCT UPSTREAM BULKHEAD FORM

Construct the upstream (waterside) bulkhead form. No. 1 grade Douglas Fir, or equivalent, is required for the timber lagging, post and sill supports. This form design is based on designs that have previously proven successful.

Construction of the upstream bulkhead shall be in accordance with these specifications, and drawings as follows:

- Plate 1. Longitudinal Cross Section of Forms, Steel Beam Supports and Contact Grout Holes,
- Plate 2. Plan View of Bulkhead Forms with Steel Beam Supports,
- Plate 3. Air Side Form Face,
- Plate 4. Air Side #9 Rebar Cage Plus Contact Grout Holes

The contractor may alter the construction sequence or specifications for the form work only with prior approval of the PROJECT MANAGER, providing a demonstration to the PROJECT MANAGER's satisfaction that the integrity of the final reinforced concrete bulkhead is not compromised.

The upstream bulkhead form construction sequence is as follows:

2.1 Cut a roughly level slot perpendicular to the tunnel axis, directly across the floor for the approximately 9-ft. long W 4x13 steel sill beam. Smooth irregularities in the slot using concrete grout as necessary. The sill beam will be cut in the field to assure that both ends of the beam are in close proximity, less than 1-in., of the tunnel wall on each end, assuring that the base of the outer 8-in. x 8-in. posts (or the four 2-in. x 10-in. composite posts) will bear against one flange of the W 4x13 beam. This is essential because the sill beam will align the three 8-in. x 8-in. posts across the tunnel on the water side form. The central 8-in. x 8-in. post shall be no more than 2-ft. 11-1/2-in. apart, center-to-center or 2-ft. 4-in. skin-to-skin. The recommended minimum center-to-center distance between the central post and one of the side posts is 2-ft. 7-1/2-in. or 2-ft. 0-in. skin-to-skin. This minimum spacing permits minimal access through the bulkhead form to the cofferdam, if required. The maximum 2-ft. 4-in. skin-to-skin distance between posts is, controlled by the strength of the 3 x 10-in. nominal (2-1/2 x 9-1/4-in. dressed) lagging.

2.2 Two 1-3/8-in. or 1-1/2-in. diameter holes will be drilled at least 6-in. apart, directly in line in front of the beam, three foot deep into the floor rock at each end of the beam. The holes will contain Grade 75 #8 resin-grouted threadbar dowels. The threadbar dowels are to project at least 3-in. upward through holes cut through the 6-in. leg of an at least 1-ft. long L 6x4x1/2 angle bracket. Threadbar nuts with washers will be attached and tightened to restrain the beam during filling of the form. The locations are as close as reasonable to the ends of the beam, as indicated on attached plates.

2.3 Stand the central 8-in. x 8-in. roof-to-floor post vertically near the tunnel centerline. Stand the two outside posts to minimize the distance the 3-in. x 10-in. lagging is cantilevered beyond the outside posts and as close as reasonably possible, but not more than 6-in.. The outside posts can be tilted to reduce the cantilevered distance, but only to the extent that the open span between the central post and the outside post does not anywhere exceed 2-ft. 4-in.

Hitches are to be cut into the back and floor for all posts to provide relatively flat bearing surfaces. Wedges will be used as needed to further tighten the posts. Bolt a 9-in. long 6-in. x 4-in. angle iron (L6x4x1/2) to the roof on the upstream side and against the top of each 8-in. x 8-in. post with one #8 fully resin-grouted threadbar un-tensioned dowels embedded at least 3-ft. into holes into the roof. Threadbar nuts with washers will be attached and tightened to restrain the post during filling of the form. See the attached plates.

2.4 Position the center of a cut-to-fit approximately 6-ft. long W 6x20 beam 2-ft. up from the floor of the tunnel and across the upstream face of the three 8-in. x 8-in. or the composite 4 each 2 x 10-in. posts. This is indicated on attached plates. Securely fasten the beam to all three posts, possibly with a lag screw anchored plate or bracket. Two 8-in. long L6x4x1/2 angle-iron will be fillet welded to beam, before the beam is taken into the tunnel, to stiffen the central post. If it is possible to determine the positions of the outer posts before moving the beam into the tunnel similar angles should be fillet welded to also brace the outer posts. These short angles are indicated on the attached plates.

2.5 Position the center of a similar cut-to-fit approximately 6-ft. long W 6x20 beam 4-ft. 6-in. up from the floor of the tunnel and across the upstream face of the three 8-in. x 8-in. or the composite 4 each 2 x 10-in. posts. This is indicated on attached plates. Securely

fasten the beam to all three posts, possibly with a lag screw anchored plate or bracket. Two 8-in. long L6x4x1/2 angle-iron will be fillet welded to beam, before the beam is taken into the tunnel, to stiffen the central post. If it is possible to determine the positions of the outer posts before moving the beam into the tunnel similar angles should be fillet welded to also brace the outer posts. These short angles are indicated on the attached plates.

2.6 Position the top of the third cut-to-fit 6-ft. long W 6x20 beam 6-ft. 9-in. up from the floor of the tunnel and across the upstream face of the three 8-in. x 8-in. or the composite 4 each 2 x 10-in. posts. This is indicated on the attached plates. Securely fasten the beam to all three posts, possibly with a lag screw anchored plate or bracket. Two 8-in. long L6x4x1/2 angle-iron will be fillet welded to beam, before the beam is taken into the tunnel, to stiffen the central post. If it is possible to determine the positions of the outer posts before moving the beam into the tunnel similar angles should be fillet welded to also brace the outer posts. These short angles are indicated on the attached plates.

2.7 Tunnel rib brackets, roughly 1-ft. 2-in. long L6x4x1/2 angle iron, anchored with two fully resin-grouted Grade 75 threadbar bolts in 1-3/8-in. or 1-1/2-in. diameter holes drilled 4-ft. deep and approximately 7-1/2-in. apart into the ribs at positions centered approximately 2-in. above and 2-in. below both ribside ends of the three W 6x20 beams. The rib brackets will also be centered approximately 2-ft., 4-ft. and 6-ft. above the floor. The irregularity of the tunnel ribs will necessitate individually installing the angle iron rib brackets. The attached plates indicate the bracket and locations. The #8 resin-grouted threadbar bolts are to project upward at least 3-in. through holes cut through the 6-in. leg of a L 6x4x1/2 angle bracket. Threadbar nuts with washers will be attached and tightened to support the design loading on the beam ends during filling of the form.

2.8 Bolt an approximately 8-in. long 6-in. x 4-in. angle iron (L6x4x1/2) to the roof on the upstream side and against the top of each 8-in. x 8-in. post with one #8 fully resin-grouted threadbar dowel embedded at least 3-ft. into a hole drilled in the roof. Threadbar nuts with washers will be attached and tightened to restrain the post during filling of the form. See attached plates.

2.9 The PROJECT MANAGER will make a final inspection of the waterside cofferdam, bypass pipe, W 4x13 sill beam, posts, W 6x20 bulkhead support beams, bolting and angle iron brackets will be inspected and must be approved before proceeding.

2.10 Place individual 3-in. x 12-in. nominal (2-1/2-in. x 11-1/4-in. dressed) or 2-in. x 4-in. (1-1/2-in. x 3-1/2-in. dressed) boards laid flat as lagging (form planks) from tunnel rib to tunnel rib, completely across the tunnel and against the 8-in. x 8-in. post supports, starting at the floor. The lagging boards are to be individually cut to fit the ribside profile. The lagging is to be stacked skin-to-skin on top of each other from the floor to the roof. The lowest and uppermost pieces of lagging will have to be cut to fit the floor and back profiles. The uppermost piece of lagging will require additional restraint between the posts by the #8 resin-grouted threadbar bolt brackets, indicated on the attached plates.

Wherever it is not possible to span the tunnel width with a single piece of lagging the lagging pieces will be butted together at the center of one of the central post. Lag bolt or nail each continuous piece of 3-in. x 12-in. lagging to at least two posts. Wherever possible wedges are to be driven between the ends of each piece of 3-in. x 12-in. lagging and the adjacent tunnel ribsides from the water side, before the next piece of lagging is cut to fit, placed, and fastened. If 2-in. x 4-in. lagging is employed the individual boards will

have to be nailed to the underlying board and the stack fastened to the central posts approximately every 12-in. Wedges are to be driven from the water side wherever gaps develop between the boards and the adjacent rock to tighten and support the cantilevered ends.

The pieces of lagging that contain the 8-in. nominal ID (4.500-in. OD) Schedule 40 stainless steel bypass pipe will have to be cut or slotted to fit as closely as possible around the bypass pipe, caulked and reinforced as necessary. Similarly, the lagging penetration for the upstream portion of the 3/4-in. nominal ID (1.050-in. OD) Schedule 40 water sampling and pressure measurement stainless steel pipe through the water side bulkhead needs to be drilled or cut, caulked and reinforced as necessary. The 3/4-in. pipe is to be positioned no closer than 2-ft. from either tunnel rib and at least 3.5-ft. up from the floor. The 3/4-in. pipe can contain two, at most, threaded union connections within the bulkhead provided these permanent connections include Teflon tape, or other thread sealant.

Drive or inject caulking material continuously between the lagging and the rock around the perimeter of the bulkhead form and the tunnel rock. Before the last of the lagging is placed between the central posts the final inspection of the cofferdam and bypass water inlet through the access opening must be performed. After that inspection, close the access opening.

2.11 Provide and install vibrating wire piezometer, cabling and data logger. CONTRACTOR will provide and install rst Instruments model PPA0094, 5.0 MPa piezometer, 300-FT. of armored cable, and model DT2055B ten-channel data logger as directed by the PROJECT MANAGER. **Armored cable is required.** Information on the rst Instruments equipment is included as Appendix D. Equivalent equipment from alternative manufacturers is acceptable if approved by the PROJECT MANAGER.

The piezometer will be hung on the water side of the bulkhead form and cable strung through the bulkhead location such that it will not be damaged during pouring of the concrete bulkhead. The cable will then be run on existing or newly installed hangers to the adit portal, and connected to the data logger installed in a secure location designated by the PROJECT MANAGER.

2.12 Nail the 1/2-in. thick plywood, or particle board, against the inner form face of the lagging (form planks). The plywood, or particle board, will have to be cut to fit the tunnel roof, ribs and floor perimeter profiles and around the bypass and water sampling and pressure measurement pipes.

Drive or inject caulking material into open spaces and continuously between the plywood, or particle board, and the rock around the perimeter of the tunnel.

2.13 Install DeNeef tube as described in Item 10.1.

2.14 Erect the two-way, shrinkage and temperature, 12-in. center-to-center, waterside, #6 rebar cage, with minimum 3.5-in. and maximum 9-in. clearance from the plywood form face, for eventual concrete cover as long-term protection against potential sulfate attack.

2.15 Stockpile the #9 steel reinforcing bars, 1/2-in. plywood or particle board and 3-in. x 12-in. or 2-in. x 4-in. lagging for the air side bulkhead form and the 3/4-in. Schedule 40 stainless water sampling and pressure measurement pipe sections necessary to complete

the water sampling and pressure measurement pipe in the bulkhead construction area before proceeding with construction of the air side bulkhead form.

ITEM 3.0: CONSTRUCT DOWNSTREAM BULKHEAD FORM

Construct the downstream (air side) bulkhead form. No. 1 grade Douglas Fir, or equivalent, is required for the timber lagging, post and sill supports. This form design is based on designs that have previously proven successful.

The downstream bulkhead form is nearly a mirror image of the upstream form. **The construction sequence for ITEM 3.0 principally repeats ITEM 2.0 as set forth above.** The same drawings as referenced in Item 2.0 above shall govern this section of the work. There are certain differences in the form and rebar cage construction as shown on the drawings, and in construction procedures as described in this section as follows:

3.1 It will not be possible to close the access opening through the two central posts into the bulkhead until:

a) The lagging, except for the access opening, is erected, wedged tight from the air side and caulked to the adjacent rock,

b) The air side lagging is fitted, caulked and reinforced around the 8-in. bypass pipe and the air side water sampling and the 3/4-in. water sampling and pressure measurement pipe penetration are made through the lagging.

c) The plywood or particle board is nailed to the lagging outside the access opening with a penetration hole for the 3/4-in. water sampling and pressure measurement pipe and the pipe sections then connected and inserted through the form, caulked and reinforced,

d) The concrete form release compound is applied to the plywood or particle board outside the access opening,

e) The two-way #9 rebar cage is erected, on 9-in. spacing, center-to-center, with minimum 3.5-in. and maximum 9-in. of clearance from the plywood form face, as long-term protection against potential sulfate attack, outside the access opening area,

f) The vertical #9 rebars in front of the access opening are tied to the lowest horizontal bar and temporarily tied to the vertical bars alongside the access opening,

g) The horizontal #9 bars, that will eventually be positioned in front of the access opening, will be hung from the uppermost horizontal bar, that has been carefully tied into all crossing vertical bars, so that the other two or three bars can be lowered into their final positions and tied into the cage from outside the access opening,

h) The PROJECT MANAGER's final inspection of the interior of the bulkhead to verify that the bulkhead forms, rebar cages, and pipes have been constructed as designed and the rebar cages and pipes are placed, supported and tied down as specified and

i) A final wet vacuum cleaning of the bulkhead floor has been completed immediately before starting to fill the bulkhead form.

3.2 NOTE: Pulling and lowering the rebar into position in front of the access opening and closing the access opening between the two central posts by inserting the lowest piece of precut lagging, complete with the plywood and form releasing compound, can only begin when the concrete filling of the form approaches that level of the lowest open lagging position. This delay is necessary in case there is a breakdown of some kind requiring entry into the bulkhead form.

ITEM 4.0 INSTALL AND REMOVE CONCRETE PUMPING AND CONVEYANCE SYSTEM

The bulkhead concrete will be pumped from the base of the mine waste rock dump through a slick-line. The contractor shall furnish and install a concrete pumping and conveyance system that is sufficient and capable of handing the pressures and pumping dynamics associated with the physical project constraints and the project requirements. The pump must be capable of pumping the mix at a sufficient pressure to completely fill the bulkhead forms. The pumping and conveyance system must be sized, configured and installed to prevent blockages (i.e. through appropriate line sizing and pre-screening concrete ahead of the pump), and allow fast and easy cleanout of blockages if they occur.

After the concrete is placed into the bulkhead forms, the Contractor shall remove the temporary conveyance system including removal of all piping and hoses.

ITEM 5.0 PROVIDE AND PLACE CONCRETE INTO BULKHEAD FORM

The CONTRACTOR shall fill the bulkhead form as a monolithic, single pour by continuously pumping the form full with approximately 27-cu.yd. of 4,000psi concrete. The profiling completed under Item 1.0 will be the basis for calculating the actual cubic yard volume for concrete required.

The CONTRACTOR must use the concrete mix design in Appendix A for 4,000 psi, self compacting concrete (SCC), or equivalent as approved by the PROJECT MANAGER. **Portland-cement used in the mix shall be type V Sulfate resistant cement. Additionally, Xypex Admix C-1000 or equivalent shall be added to the mix design as concrete waterproofing.** Xypex shall be added to the mix design per manufacturer's specifications included in Appendix C.

It is critical that the concrete be placed to prevent honey combing. It is also critical that the bulkhead be completed in a single, continuous concrete pour, but if the concrete filling process is interrupted for more than 6 hours, the Contractor must prepare a construction (cold) joint before resuming concrete filling by:

a) Entering the bulkhead and using a plywood support, move roughly to the center of the form,

b) Shoveling an approximately 1-ft. deep trench across the surface of the fresh concrete and

c) Applying a bonding agent to the surface of the fresh concrete (such as ThoRoc's "Epoxy adhesive 24LPL").

ITEM 6.0 CONCRETE TESTING

A set of three 6-in diameter by 12-in long cylindrical test samples are to be collected from each 5 cubic yards of concrete pumped to the bulkhead location. Sampling may occur at the concrete trucks, and is not required at the bulkhead location.

Approximately 6 sets of three samples each are to be collected. The concrete test samples are to be prepared in accordance with ASTM Designation C 31/C 31M-98, *Standard Practice for Making and Curing Concrete Test Specimens in the Field*. The 6-in diameter by 12-in long test specimens will be molded and rodded in plastic molds, marked for identification, placed in heavyweight plastic bags and stored on a level surface in the tunnel near the bulkhead location. After 7 days, two samples from each set will be transported in carefully packed boxes to a testing lab for final curing in a moist room. One test sample from each set will be tested for the seven-day compressive strength and the other for the 28-day compressive strength. The final sample from each set for the second 28-day test will remain underground in a safe location as near to the bulkhead location as possible. After 28 days they will be transported to the testing lab for the final set of test beaks.

ITEM 7.0 CONTACT GROUTING

If the PROJECT MANAGER approves the 7-day mean concrete compression strength test results as equal or exceeding 3,000psi, the upper 4-ft. of the downstream bulkhead form can be stripped to provide access for drilling and contact grouting.

ITEM 7.1 DRILL CONTACT GROUT HOLES

Once approval of the minimum 3,400 psi, 28-day compressive strength is received from the PROJECT MANAGER, the CONTRACTOR can establish the Contact Grouting operations. Drilling equipment and supplies are set up at the downstream bulkhead location. The upper 4-ft. of the downstream bulkhead form can be stripped to provide access for drilling and contact grouting. Hole size chosen must be compatible with the contractor's packer size and grouting equipment. Jackleg drilling may be used to advance the contact grout holes. Drilling must be done wet; water for drilling can be supplied by a jack-tank arrangement.

Drilling Logs

Contractor must log contact-grout drill holes on a pre-printed drilling log form, which must include the date the hole was drilled, the number or designation of the hole, the total depth drilled, and the position of the concrete-bedrock contact in the drill hole. Copies of contact grout hole drilling logs shall be provided to the PROJECT MANAGER.

Drilling Procedure

Drill one or more of the three longer concrete/bedrock contact grout holes toward known high locations in the adit roof area (as established by profiling in Item 1.0 above), between approximately 7.5-ft. and 14-ft. from the downstream bulkhead face, as directed by the PROJECT MANAGER. Otherwise follow the pattern shown on the attached plates. The length of these grout holes must be sufficient to penetrate about 6-in. into the rock, as indicated by a decrease in the drilling advance rate and by a change in the color of the circulation water and cuttings. NOTE: THE POSITION OF THE CONCRETE-BEDROCK CONTACT MUST BE RECORDED ON THE DRILL LOG FOR ALL HOLES. These longer holes must be grouted first.

Following grouting of the longer holes, drill the four shorter concrete/rock contact grout holes toward high locations in the granite roof area between approximately 1-ft. and 7.5-ft. from the downstream bulkhead face, if any are known from the profiling conducted in Item 3.0. The length of these grout holes must be sufficient to penetrate about 6-in. into the rock, as indicated by a decrease in the drilling advance rate and by a change in the color of the circulation water and cuttings. NOTE: THE POSITION OF THE CONCRETE-GNEISS CONTACT MUST BE RECORDED ON THE DRILL LOG FOR ALL HOLES.

ITEM 7.2 ESTABLISH CONTACT GROUT OPERATIONS

The contractor shall establish and conduct the Contact Grouting Program in conformance with these specifications, and generally accepted industry practice, as set forth by the Portland Cement Association Handbook, *Cementitious Grouts and Grouting*. Grout shall consist of a neat type-V cement grout. Mix water must be free of deleterious substances (mine discharge water is not permitted to be used for mixing grout). Water must be supplied from clean sources and pumped in from surface, or via at least two portable tanks that can be brought into the tunnel during grouting.

Upon completion of the Contact grouting work, the Contractor shall remove all equipment and materials from the underground work area, including any un-used cement.

Grouting Logs

The Contractor must record all grouting activities on pre-printed grout logs approved beforehand by the PROJECT MANAGER. The log must include the date, hole number, grout mix data (W:C ratio and density), injection pressure, grout take in cubic feet, and all other variables used to grout the hole.

Grouting Equipment

The Contractor must batch, mix, and inject cement grout at the bulkhead location. Neat cement grout may not be mixed and batched at surface or pumped through the slick line installed under Item 4.0. A high-shear colloidal mixer unit specifically designed for batching and mixing neat-cement grouts is required (e.g. *ChemGrout CG-600/8CF/A, CG-620/A or equivalent specification coloidal unit*). Pumping units may be positive displacement piston-type or progressive-cavity (Moyno) type (e.g. Chem Grout *CG-600/8CF/A, CG-030, CG-L4A etc.)* The unit must supply grout to a maximum pressure of 450 psi. (www.chemgrout.com)

A re-circulating-type grout delivery manifold system is required. The manifold and valve system must allow for continuous recirculation of grout back to the grout holding tank. Pressure to the hole being grouted is controlled by closing/opening the return-circulation valve. Suitable diaphragm-protected pressure gauges with appropriate dial scales are required, and headers on the mechanical packers at each hole must be equipped with a gauge and shut-off or holding valve that will maintain grout pressure in the hole when the delivery manifold is disconnected.

ITEM 7.3 PROVIDE AND INJECT CONTACT GROUT

The PROJECT MANAGER must be present during all grout-injection work. The Contractor must record all grouting activities on pre-printed grout logs, format of which is approved beforehand by the PROJECT MANAGER. The log must include the date, hole number, grout mix data (W:C ratio and density), injection pressure, grout take, and all other variables used to grout the hole.

Grout Mix Design and Density Measurement

Grout shall consist of a neat Type-V cement grout (Type-V cement and water). Cement must be Type-V sulfate resistant. Mix water must be free of deleterious substances (mine discharge water is not permitted to be used for mixing grout). Water must be supplied from clean sources and pumped in from surface, or via at least two portable tanks that can be brought into the tunnel during grouting.

The injected mix shall have a water-cement ratio of 2:1 by weight. Depending on take and pressure, the contractor's mixing and pumping equipment must be capable of varying the water-cement ratio from 0.6:1 to 3:1 as directed by the PROJECT MANAGER. Admixtures that control bleed, improve flowability, reduce water content, and retard set may be used in the grout, subject to review and acceptance by the PROJECT MANAGER.

Grout specific gravity and density must be measured per ASTM C109 or API RP-13B-1, at a frequency of no less than one test per-batch conducted prior to injection, and recorded on grouting logs. The Baroid Mud Balance used in accordance with API RP-13B-1 is an approved device for determining grout density.

Grouting Procedure

A mechanical or inflatable packer compatible with the hole size used in Item 7.1 above is to be set at least 6 inches outboard of the concrete/bedrock contact and roughly halfway up the grout hole. Grout injection pressure should reach at least 90 psi, but not more than 450 psi. The minimum grout pressure is to be maintained for three minutes or until three bags (3-cubic feet) of grout have been injected, or whenever grout returns from an adjacent grout hole.

If the grout take in one hole reaches three cubic feet without reaching the minimum 90 psi injection pressure, grouting is to be stopped, the packer pressure released, the packer removed and the grout allowed to reach initial set for 8 hours. The CONTRACTOR will make an immediate written record of the grout take after each grouting cycle for each hole.

If grout refusal occurs, or when the minimum grout pressure is reached and held for three minutes, the hole is to be grouted full and not re-grouted. If other grout holes have been drilled they can be grouted during the initial set time. After initial set in each grouted hole, the packer will be reset at the face of the bulkhead and the remainder of the hole filled with grout using a vent-tube return through the packer.

A hole that had greater than 3 cubic feet of take will be re-drilled and the grouting process repeated after the initial grout set, as directed by the PROJECT MANAGER. The set time can be shortened provided the measured tunnel temperature indicates that this is reasonable, and the PROJECT MANAGER concurs. The grout holes will be re-drilled and re-grouted until the minimum grout pressure can be maintained for three minutes.

ITEM 8.0 DENEEF TUBE GROUTING

In addition to contact grouting, DeNeef tubes will be installed and grouted to reduce any additional leakage along the concrete/bedrock contact. CONTRACTOR must use DeNeef products or approved equivalent as described below and included in Appendix B. Consultation with the manufacturer's representative is required. A site inspection by the manufacturer's representative

may be required by the PROJECT MANAGER. DeNeef tube grouting shall not take place until all contact grout operations have been completed.

ITEM 8.1 SUPPLY AND INSTALL DENEEF TUBE

CONTRACTOR must supply and install 1/2-in. DeNeef Injecto® tube per manufactures guidance and recommendations. The tube must be continuously tight against the rock. Two complete rings shall be installed along the adit perimeter at locations established by the PROJECT MANAGER . Grout tube must be installed prior to completing the downstream bulkhead form, and must be attached to the rock perimeter per manufacture's specification. The injection point for each ring shall penetrate the formwork at the edge of the form.

ITEM 8.2 PROVIDE AND INJECT DENEEF GROUT

Following certification by the PROJECT MANAGER that all 28-day concrete breaks have met design compressive strength, DeNeef grout tubes shall be grouted. Contractor must supply and inject DeNeef Injecto® PURe grout and Flex Cat PURe or alternate grout product recommended by the manufacturer and approved by the PROJECT MANAGER. Grout shall be injected into both grout tube rings to reduce or eliminate any seepage along the concrete/bedrock contact. Grout and catalyst shall be mixed and injected in accordance with manufacturer's recommendations. Manufacturer's mix recommendations of 1% catalyst to resin shall be adhered to.

CONTRACTOR shall supply and setup all equipment required to inject the grout tubes. Grout tube injection pressures must reach a minimum of 90 psi, but shall not exceed 450 psi.

ITEM 9.0 STRIP FORMS AND INSTALL VALVE AND PRESSURE GAUGE EQUIPMENT

After completion of the contact grouting program, permanent protective supports will be placed under and around the valve manifold for its protection. The remainder of the downstream (air side) form will be also be stripped, and all the removed materials taken outside for proper disposal during project de-mobilization. A stainless steel globe valve rated to 600 psi will be permanently attached to the threaded end of the 3/4-in. water sampling and pressure measurement pipe. Provide and install a stainless steel analog pressure gauge with a psi range of 0-600, 20 psi major graduations, and 2 psi minor graduations. All pipe and valve connections will be made using Teflon tape, or other thread sealant. All fittings, pipe, and valves are schedule-40 stainless steel.

PROJECT OBSERVATION

The PROJECT MANAGER will be at the project site periodically to monitor construction activities and ensure that each work item is completed and constructed to design specifications. It is the Contractor's responsibility to schedule inspections with the PROJECT MANAGER so as not to delay the work. The following items must be observed and approved by the PROJECT MANAGER before proceeding with the next step of the work:

Item/Task	INSPECTION ITEM
ITEM 1.0	Prepared bulkhead area will be inspected, measured and profiled. Profile provided to the PROJECT MANAGER.

ITEM 2.0 The PROJECT MANAGER will make a final inspection of the cofferdams, bypass pipe, bulkhead sill, posts, bracing, bolting and angle iron brackets and this must be approved before placing the last of the lagging, closing the water side access opening.

The PROJECT MANAGER must perform final inspection of the interior of the bulkhead to verify that the bulkhead forms, rebar cages, and pipes have been constructed as designed and the rebar cages and pipes are placed, supported and tied down as specified, and a final wet vacuum cleaning of the bulkhead floor has been completed immediately before starting to fill the bulkhead with concrete.

ITEM 3.0 The PROJECT MANAGER will make a final inspection of the waterside cofferdam, bypass pipe, W4x13 sill beam, posts, W6x20 bulkhead support beams, bolting and angle iron brackets will be inspected and must be approved before closing the waterside access opening.

The PROJECT MANAGER's final inspection of the interior of the bulkhead to verify that the bulkhead forms, rebar cages, and pipes have been constructed as designed and the rebar cages and pipes are placed, supported and tied down as specified, and a final wet vacuum cleaning of the bulkhead floor has been completed immediately before starting to fill the bulkhead form.

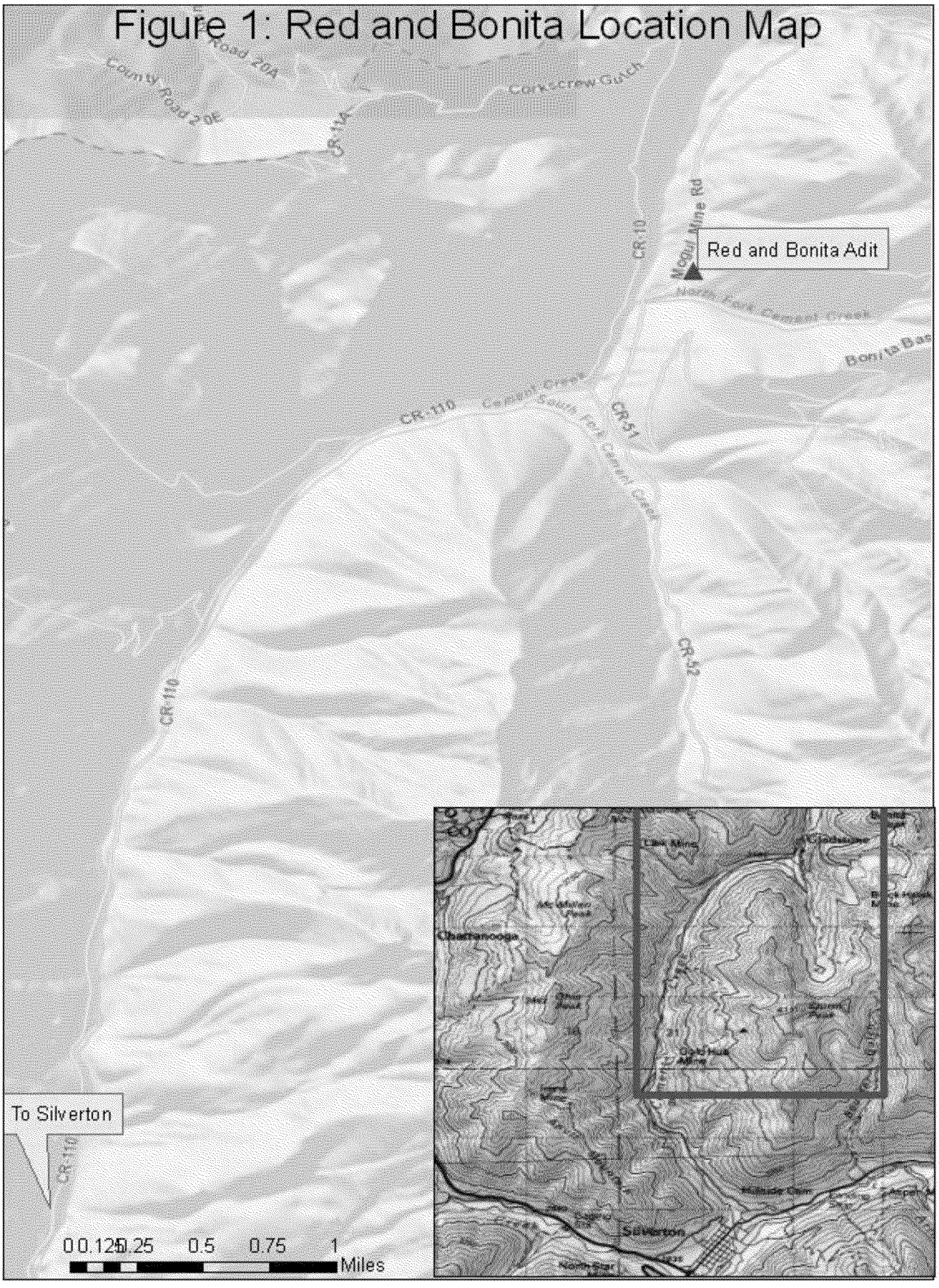
ITEM 5.0 The PROJECT MANAGER must be present during all concrete placement into the Bulkhead forms.

ITEM 6.0 After all the seven day test results have been received from the lab, the gate valve can be closed and the temporary air side (downstream) bypass pipe can be disconnected, provided the mean 7-day concrete compression strength test results exceed 3,000 psi and if approved by the PROJECT MANAGER.

ITEM 7.0 The PROJECT MANAGER must be present during all grout injection work. Grout holes can be re-drilled and the grouting process repeated after the initial set time as directed by the PROJECT MANAGER. The set time can be shortened provided the measured tunnel temperature indicates that is reasonable, and the PROJECT MANAGER concurs. Drilling and Grouting Logs must be provided to the PROJECT MANAGER.

ITEM 8.0 The PROJECT MANAGER must be present during all DeNeef grout tube injection.

Figure 1: Red and Bonita Location Map



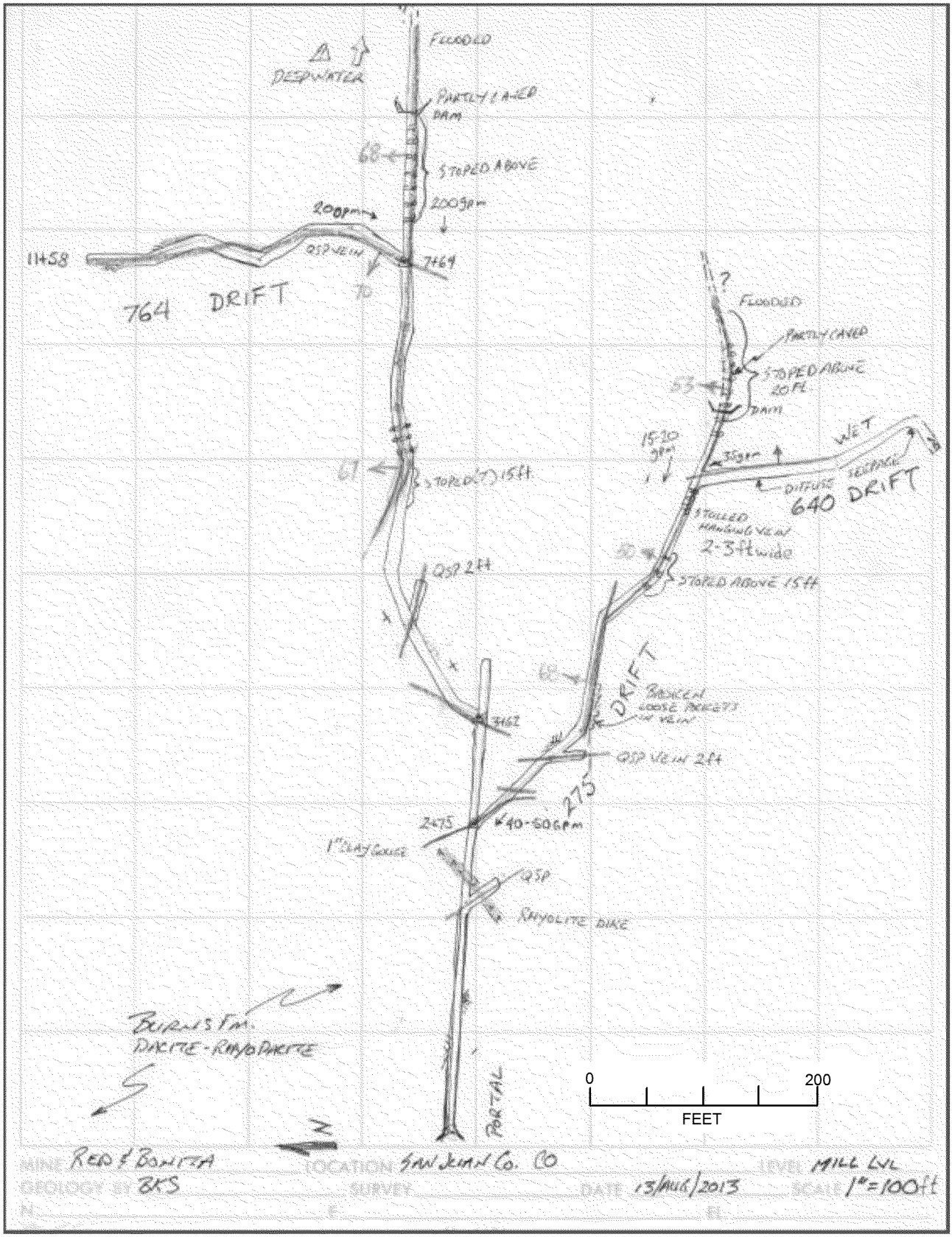


Figure 2: Red and Bonita Mine Map

LONGITUDINAL CROSS SECTION OF BULKHEAD

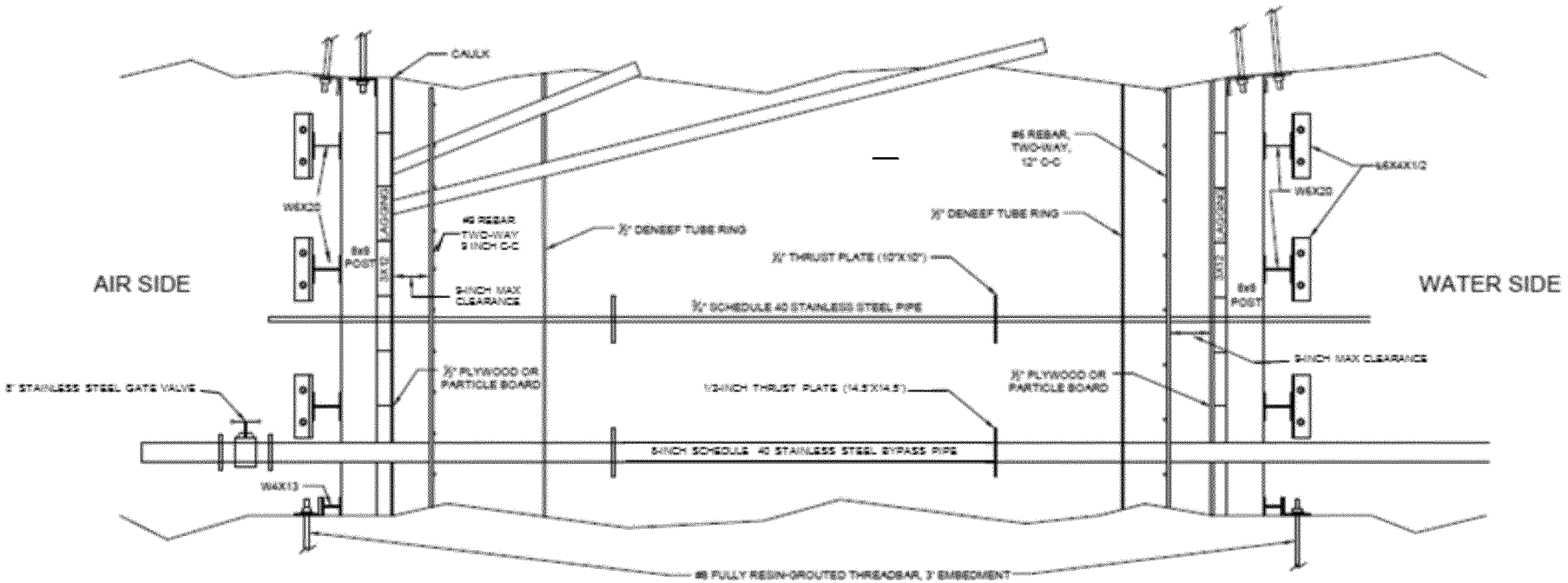


PLATE 1	RED AND BONITA MINE BULKHEAD
SCALE 0 FT — 5 FT	COLORADO Division of Reclamation, Mining and Safety Department of Natural Resources

PLAN VIEW OF BULKHEAD

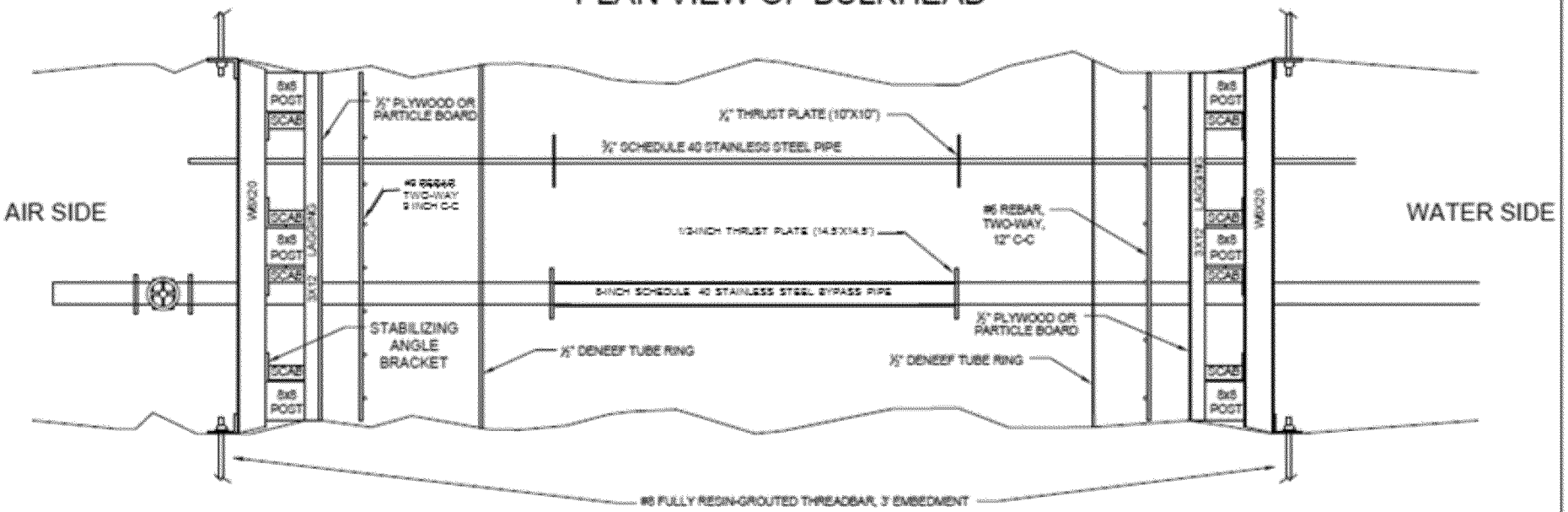


PLATE 2	RED AND BONITA MINE BULKHEAD
SCALE 0 FT — 5 FT	COLORADO Division of Reclamation, Mining and Safety Department of Natural Resources

AIR SIDE FORM FACE

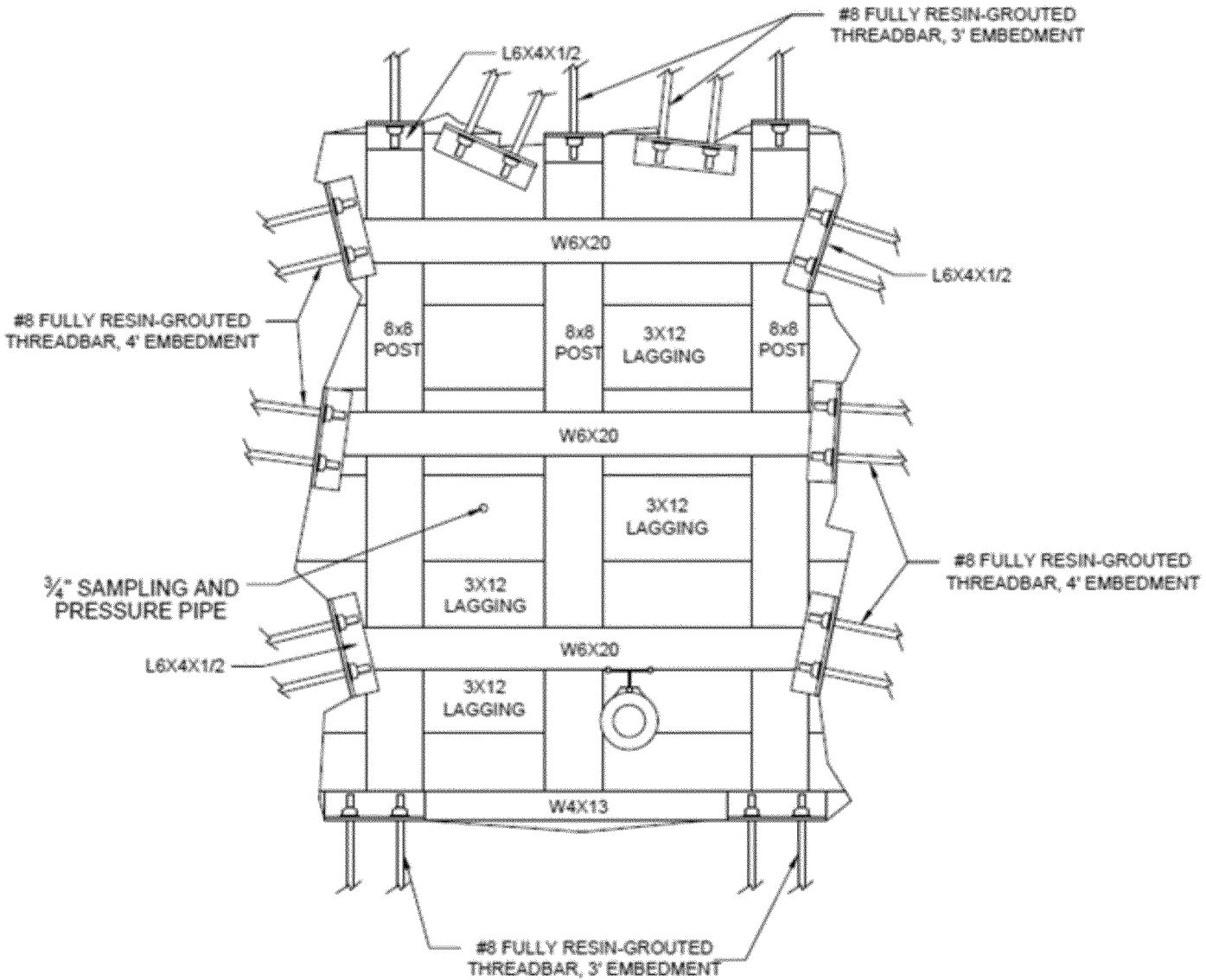


PLATE 3	SCALE 0 FT — 2 FT	RED AND BONITA MINE BULKHEAD	COLORADO Division of Reclamation, Mining and Safety Department of Natural Resources

AIR SIDE #9 REBAR CAGE AND CONTACT GROUT HOLES

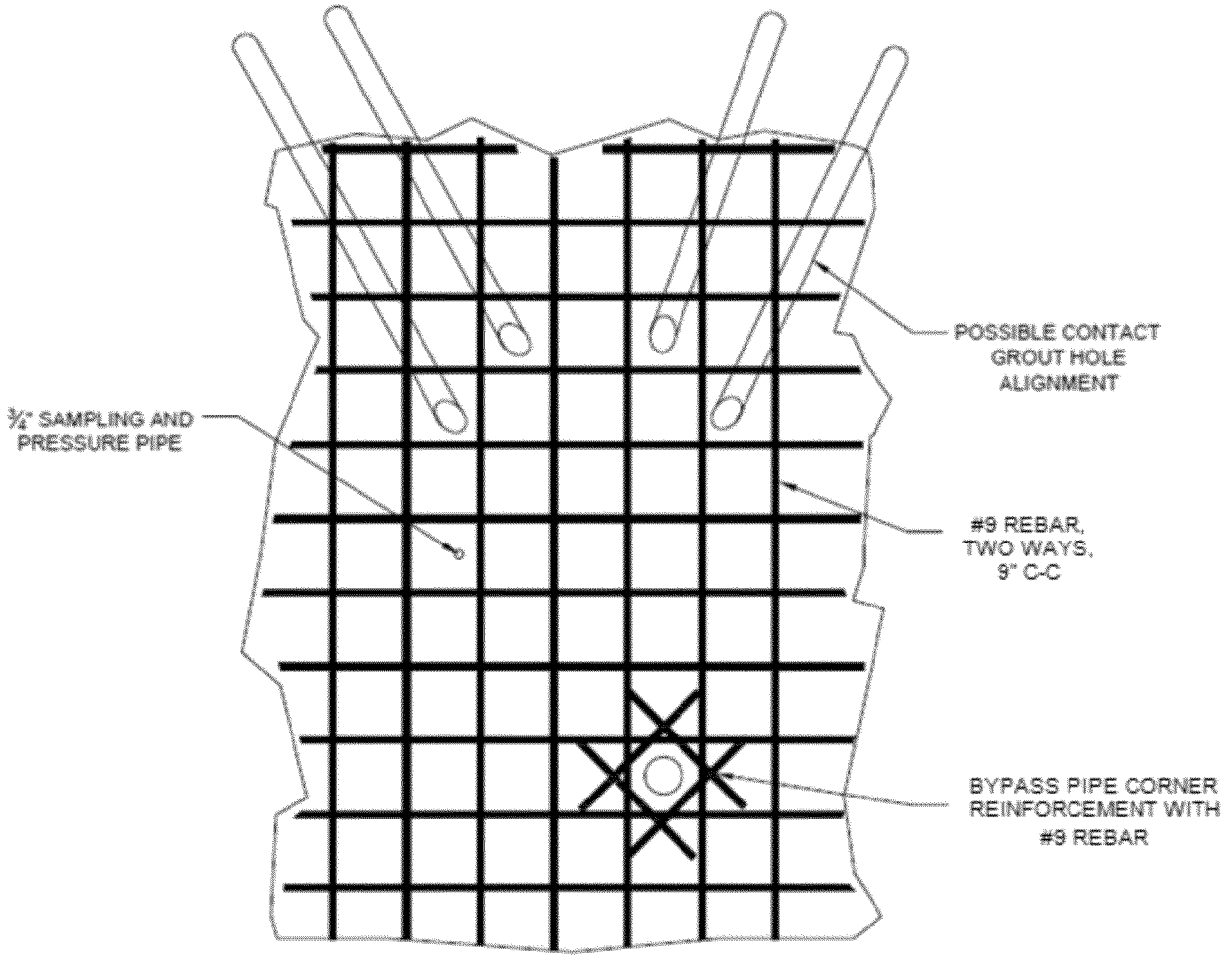


PLATE 4	SCALE 0 FT — 2 FT	RED AND BONITA MINE BULKHEAD	COLORADO Division of Reclamation, Mining and Safety Department of Natural Resources

APPENDIX A
CONCRETE MIX SPECIFICATION

Cement:	ASTM C 150 - Type V
Fly Ash:	ASTM C 618 - Class F
Admixtures:	ASTM C 494 - Type F
	Viscosity Modifying Admixture
Aggregates:	ASTM C 33 - Coarse Aggregate – No. 57/67
	ASTM C 33 - Fine Aggregate – Washed Concrete Sand
Water:	ASTM C 94

CONCRETE MIX INFORMATION

Identification No: 640300SC

MIX PROPORTIONS (Per one cubic yard of Concrete)

Cement	559 lbs.
Fly-Ash	240 lbs.
Coarse Agg.	1160 lbs.
Fine Agg.	1750 lbs.
Type F	5oz/cwt - 10oz/cwt
VMA	2oz/cwt - 4oz/cwt
Water	293 lbs. (35 gal.)

These weights are based on S.S.D. condition and will be adjusted accordingly as the moisture varies in the aggregates.

PHYSICAL PROPERTIES OF CONCRETE

Unit Wt. Of fresh Concrete, (ASTM C 138), pcf:	145.0 to 150.0
Slump, (ASTM C143), inches:	25 - 30"
Air Content, (ASTM C 231, Pressure Method), %:	1 - 3%
Water/Cementations Materials Ratio:	0.40

COMPRESSIVE STRENGTH

56-DAY

4000 PSI

APPENDIX B
DE NEEF GROUT INFORMATION

de neef®

INJECTO®PURe

Product Description

Injecto PURe is an ultra low viscosity hydrophobic polyurethane designed to be used with INJECTO® Grout Tube for sealing construction joints. Injecto PURe grout expands on contact with water and quickly cures to a tough, flexible foam that is resistant to most organic solvents, mild acids, alkali, petroleum and micro-organisms.

Phthalate free- no phthalate-based plasticizers

Unregulated for transport- no hazmat shipping

Reformulated TDI free-all MDI based technology.

environmentally friendly-NSF/ANSI 61 approved.

INJECTO PURe when combined with Flex Cat PURe is certified by WQA to NSF/ANSI 61 for materials safety only, as verified and substantiated by test data.
Please refer to WQA website(www.wqa.org) for use ratios and limitations

Product Advantages

Contains no volatile solvents

Single Component

Controlled reaction time

Improved low temperature performance

Flex Cat PURe liquid to -40°F

Applications

•Repairing existing leaky joints
•Waterstop for new concrete structures
•Injection through these grout tubes to form a flexible waterstop in concrete joints:

INJECTO® Tube
SIS INJECTO® Tube
BENTOJECT
TRIOJECT

Properties

Injecto PURe Grout		
Solids	100%	ASTM D2369
Viscosity	200 cps at 77°F	ASTM D2196
Color	Pale Yellow	
Density	1.02 g/cm^3	ASTM D4659
Flashpoint	>270°F	ASTM D93
Corrosiveness	Non-corrosive	
Flex Cat PURe		
Viscosity	15 cps at 77°F	ASTM D2196
Color	Clear to pale gray	
Flashpoint	221°F	ASTM D93
Injecto PURe Cured		
Density free	about 3 PCF	ASTM D3574
Tensile	>174 psi	ASTM D3574
Elongation %	100	ASTM D3574

Packaging & Handling

Injecto PURe: 5 gallon metal pail
50 gallon metal drum
Flex Cat PURe: 25 fl.oz. in 1 qt. metal cans

Injecto PURe is sealed under dry nitrogen because it is sensitive to moisture, and should be stored in original containers in a dry area. Storage temperature must be between 40°F and 90°F. Once the packaging has been opened, the useful life of the material is greatly reduced and should be used as soon as possible. Shelf life: 2 years.

Installation Guidelines

Warning: Consult the Technical Data Sheets and MSDS before using.

Installation Instructions: For detailed installation instructions refer to the DeNeef technical bulletin for your application.

Catalyst: Shake catalyst can 2-3 minutes. Pour the desired amount of Injecto PURe into a clean dry pail. Measure 1% Flex Cat PURe and pour it into the pail. Stir until adequately mixed. Exceeding the recommended amount of catalyst may adversely affect the reaction and quality of the cured foam. (1 catalyst can capful=0.5 oz; 1.3 oz/gal resin = 1%)

Injection: Injectable tubes should be adequately flushed with water prior to the injection of grout. During injection the grout will follow the path of least resistance. When the material has stopped penetrating it will continue to expand against the limits of the confined space and compress within itself,forming a dense, closed cell foam. See INJECTO Grout Tube Installation procedures for more detail.

Extreme conditions: For application procedures in extreme temperatures and specific environments or equipment recommendations call the DeNeef Technical Service Department.

Cleaning: Clean all tools and equipment which have been in contact with the resin with DeNeef Washing Agent before resin has cured. Products should be disposed of according to local, state, and federal laws.

Health and Safety

Always use protective clothing, gloves and goggles consistent with OSHA regulations. Avoid eye and skin contact. Do not ingest. Refer to MSDS. For emergencies, call CHEMTREC 1-800-424-9300.

Limitations

Low temperatures will significantly affect viscosity. Injecto PURe is not designed for void filling and must be used in compression. If site temperatures are extremely low, heat bands or heated water baths may be used on the pails before and during installation to maintain the product's temperature. Avoid splashing water into open containers, as the material is water activated. Avoid exceeding 90°F when warming.

CAUTION: pH NOTICE. Water used to activate PURe Grouts must be in the pH range of 3-10 for optimum foam quality.

Rev. 02/2013

www.deneef.com

Technical Service 1-800-732-0166

DN-010 Printed in U.S.A. 12/11 FA/PDF

de neef®

INJECTO® Tube
Groutable Hose Waterstop System

Product Description

INJECTO is an injectable waterstop system that provides a conduit for the placement of DeNeef chemical grouts. The ½" (12mm) permeable tube is installed before the concrete pour, but not injected until after the shrinkage associated with the curing concrete process is complete. This allows the cracks to open fully before permanently sealing the interfaces and voids within construction joints, pipe penetrations, slurry walls, and slab connections with chemical grout.

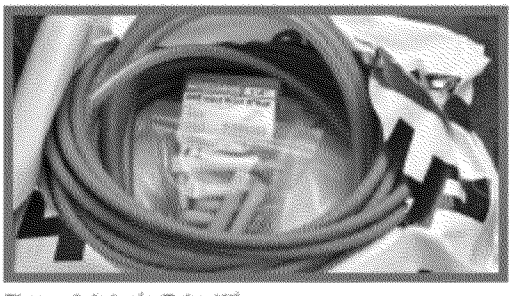


Figure 1. Injecto Tube Kit.

Product Advantages

Fast, simple installation

No special tools required

Low pressure injection

Permanent seal after injection

Injectable anytime after concrete cure

INJECTO System Warranty

Applications

- Sealing cold and construction joints
- Sealing pipe penetrations
- Sealing joints between slurry walls and slabs

INJECTO Tube may be used with the following chemical grouts:

- Flex SLV PURe with 1% Flex Cat PURe
- Flex LV PURe with 1% Flex Cat PURe
- Superflex AR Acrylate prepared according to data sheet.

Properties

Typical Properties	
Outside Diameter	1/2 inch
Inside Diameter	5/16 inch
Length	Maximum 25 ft.
Weight	4.5 lbs per 25 ft.
Operating temperature	Up to 158°F
Tensile strength steel wire	Approx. 261,000 psi
Diameter filter pores	35 microns

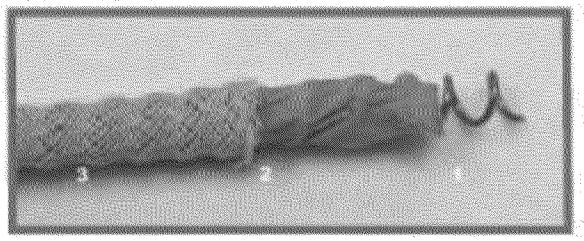
Note: The data shown above reflects typical results based on laboratory testing under controlled conditions. Reasonable variations from the data shown above may result.

Packaging & Handling

INJECTO Tube is supplied in 100 ft. kits to allow the system to be cut to length on site. The maximum recommended cut length of **INJECTO Tube** to be installed between packers is 25 ft. (see figure #1)
Yellow INJECTO Tube: 100 ft.
Clear PVC Packer Tubing : 18 ft.
Blue trumpets: 12 pieces.
Anchoring clips: 100 pieces.
1 Pallet = 40x100 ft. kits = 4000 ft.

Unlimited shelf life when stored in a dry place.

Injecto Tube Construction



A high strength spiral wire coil (1) prevents collapse during concrete placement, while the non-woven filter membrane (2) prevents the tube from being clogged with concrete particles. A bright yellow reinforced mesh sleeve (3) protects the tube and allows for easy inspection before the pour. Wherever old to new concrete surfaces join, the INJECTO Tube system can be easily installed.

Installation Guidelines

The yellow INJECTO Tube is installed onto the hardened concrete during formwork installation. In case of rough surfaces, any gap between INJECTO Tube and the surface should be filled with SWELLSEAL®WA.

The yellow INJECTO Tube is cut to the required length on the job site. (recommended length 25 ft. or less). The cut ends are smoothed with a twist; then the blue trumpets are installed over the yellow INJECTO Tube and screwed down to the stop mark inside the trumpet.(Figure 3)

The yellow INJECTO Tube is attached to the concrete with the anchoring clips between the inner and outer reinforcing bars. Attach the anchoring clips to the concrete every 12 inches with concrete anchors or nails applied with a powder actuated system (see figures 5, 6 & 7)

The blue trumpets provide a connection between the yellow INJECTO Tube and the clear packer tubing. Trumpets on adjacent runs should be installed with the wide ends of the trumpets (where the yellow INJECTO Tube is attached) in line with each other and the two trumpets separated by 2-3 inches (see figure 8). This will help avoid cross contamination of the yellow INJECTO Tubes during the grouting operation.

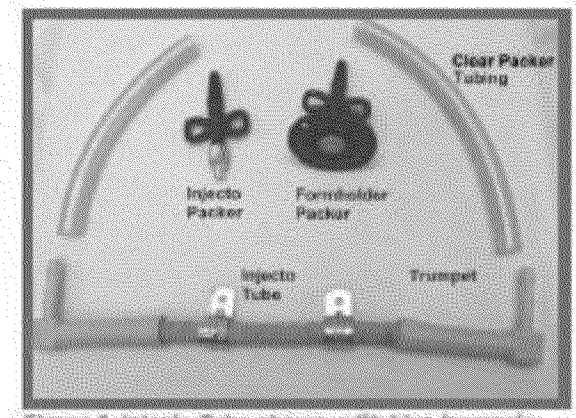


Figure 3. Injecto Tube shown with blue trumpets

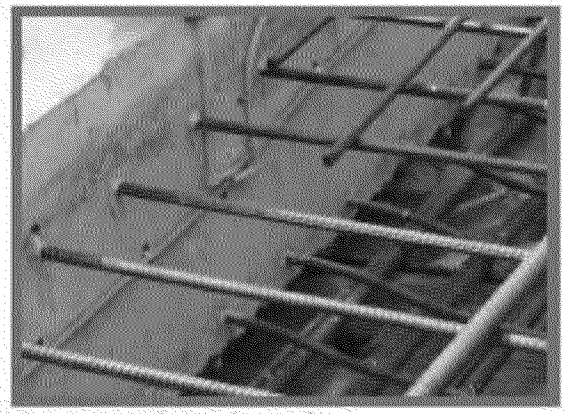


Figure 4. Position of trumpets.

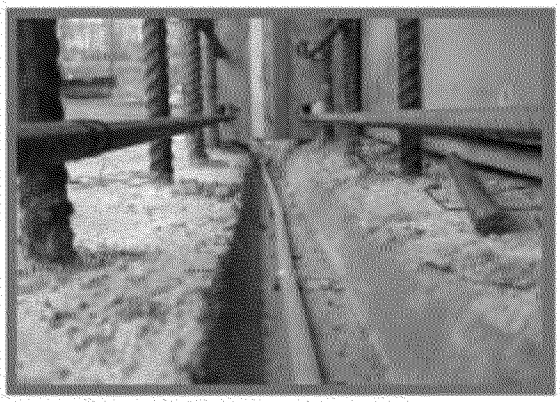


Figure 5. Anchoring clips on injecto.

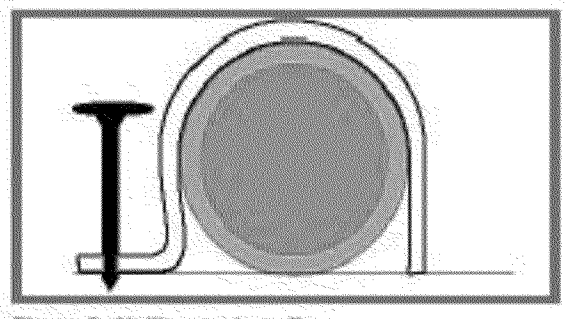


Figure 6. Nailing anchor clips

Always terminate the yellow INJECTO Tube into a trumpet and allow for a minimum of 2-1/2" of concrete cover. **Do not run the yellow INJECTO Tube outside the formwork.**

Attach the clear packer tubing over the serrated end of the trumpets. Then cut the appropriate length of packer tubing as required to reach a formholder packer or to extend outside the formwork. The clear packer tubing should be secured with tie wire to the rebar to prevent movement during the pour.

The formholder packers can be either nailed to wooden formwork or attached to the rebar with steel tie wire if metal forms are used. If formholder packers are used, attach the clear packer tubing directly to them If the clear packer tubing is being run outside the formwork, protect the open ends with a plastic cap or tape and take measures to protect them from damage during formwork installation and stripping.

The INJECTO Tube System is ideal for unique and problem details such as pipe penetrations and attaching to conventional PVC waterstops that may encounter very high head pressures (see figures 9 and 10).

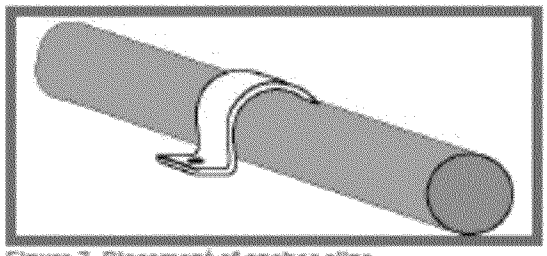


Figure 7. Placement of anchor clips

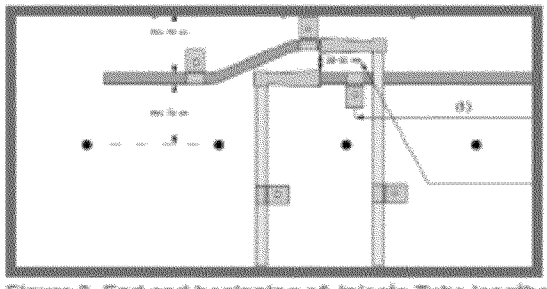


Figure 8. End and beginning of Injecto Tube lengths.

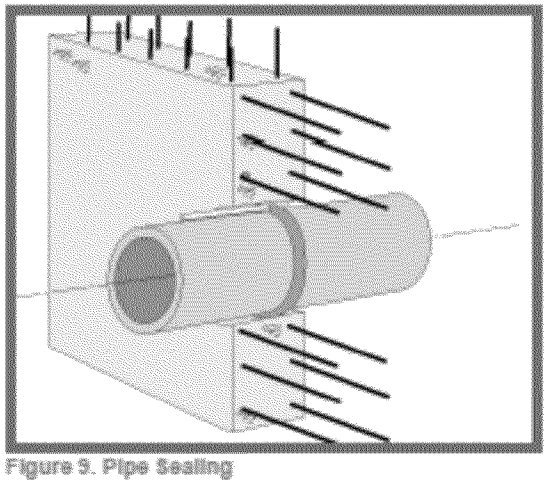


Figure 9. Pipe Sealing

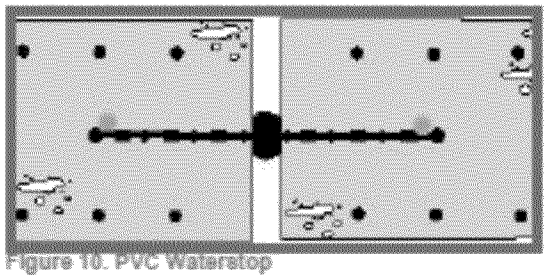


Figure 10. PVC Waterstop

CAUTIONS:

1. The yellow INJECTO Tube must be installed in direct contact with the joint over its full length, to allow proper and complete distribution of the injection resin. If the concrete is not smooth enough to allow full contact, use SWELLSEAL® WA to create a smooth surface. Press INJECTO into the SWELLSEAL WA.

2. Do not cross the yellow INJECTO Tubes. Yellow should never touch yellow or cross contamination could occur during the grouting operation.

3. The ends and beginnings of yellow INJECTO Tube lengths should be done as in figures 4 and 8 to prevent cross contamination during the resin injection process.

4. Concrete coverage must be a minimum of 2 ½" on all sides. After concrete has cured for the recommended 28 days, any water infiltrating into the joint will be collected by the system and appear through the clear packer tubing. The tubing should either protrude out of the concrete at easily accessible places or be connected to a formholder packer.

The INJECTO Tube system is designed to provide a delivery system for waterproofing resins, which are injected into the structure in accordance with the instructions found in the selected injection resins technical data sheets. Consult with the DeNeef Technical Department for assistance in selecting the appropriate sealing resin for each condition.

Always use protective clothing, gloves and goggles consistent with OSHA regulations during use. Avoid eye and skin contact. Do not ingest. Refer to Safety Data Sheet (SDS) for detailed safety precautions.

In the event of an EMERGENCY call:

CHEMTREC 800-424-9300.

Limitations

INJECTO Tube waterstop system must be installed by an Approved DeNeef **INJECTO** Applicator in accordance with the **INJECTO** Manual for Warranty to be effective. Concrete cover must be a minimum of 2 ½" on all sides.

Revised 04/2013

Health and Safety

www.deneef.com

Technical Service 1-800-732-0166

DN-037 Printed in U.S.A. 12/11 FA/PDF

APPENDIX C
XYPEX CONCRETE ADMIXTURE INFORMATION

ADMIX C-1000

07160 | CEMENTITIOUS CRYSTALLINE

Concrete Waterproofing

Description

Xypex is a unique chemical treatment for the waterproofing, protection and improvement of concrete. XYPEX ADMIX C-1000 is added to the concrete mix at the time of batching. Xypex Admix C-1000 consists of Portland cement, very fine treated silica sand and various active, proprietary chemicals. These active chemicals react with the moisture in fresh concrete and with the by-products of cement hydration to cause a catalytic reaction which generates a non-soluble crystalline formation throughout the pores and capillary tracts of the concrete. Thus the concrete becomes permanently sealed against the penetration of water or liquids from any direction. The concrete is also protected from deterioration due to harsh environmental conditions.

Xypex Admix C-Series

The Admix C-Series has been specially formulated to meet varying project and temperature conditions. **Xypex Admix C-500** is specifically formulated to meet modern concrete practices that incorporate additives such as fly ash and slag. For most concrete mix designs adding the Admix C-500 will have minimal or no effect on setting time. **Xypex Admix C-1000** is designed for typical Portland cement-rich concrete, where normal to a mild retarded set is desired. **Xypex Admix C-2000** is designed for projects where extended retardation is required due to high ambient temperatures or long ready-mix delivery times. See Setting Time and Strength for more details. Consult with a Xypex technical services representative for the most appropriate Xypex Admix for your project.

Recommended for:

- Reservoirs
- Sewage and Water Treatment Plants
- Secondary Containment Structures
- Tunnels and Subway Systems
- Underground Vaults
- Foundations
- Parking Structures
- Swimming Pools
- Precast Components

Advantages

- Resists extreme hydrostatic pressure from either positive or negative surface of the concrete
- Becomes an integral part of the substrate
- Highly resistant to aggressive chemicals
- Can seal static hairline cracks up to 0.4 mm
- Allows concrete to breathe
- Non-toxic
- Less costly to apply than most other methods
- Permanent
- Added to the concrete at time of batching and therefore is not subject to climatic restraints
- Increases flexibility in construction scheduling

Packaging

Xypex Admix C-1000 is packaged in 60 lb. (27.2 kg) pails and 50 lb. (22.7 kg) bags. Admix C-1000 is also available in cartons containing 10 lb. (4.5 kg), 12 lb. (5.5 kg), and 15 lb. (6.8 kg) soluble bags. For specific projects, contact the manufacturer for availability of custom sized packaging.

Storage

Xypex products must be stored dry at a minimum temperature of 45ºF (7ºC). Shelf life is one year when stored under proper conditions.

Dosage Rates

Xypex Admix C-1000:
2% - 3% by weight of cement

Xypex Admix C-1000 NF (No Fines Grade):
1% - 1.5% by weight of cement

NOTE: Under certain conditions, the dosage rate for No Fines Grade may be as low as 0.8% depending on the quantity and type of total cementitious materials. The maximum use level is 2% by weight of cement for potable water applications.

Consult with Xypex's Technical Services Department for assistance in determining the appropriate dosage rate and for further information regarding enhanced chemical resistance, optimum concrete performance, or meeting the specific requirements and conditions of your project.

Test Data

PERMEABILITY

U.S. Army Corps of Engineers CRD C48-73, "Permeability of Concrete", Aviles Engineering Corp., Houston, USA

Two concrete samples containing Xypex Admix at 3% and 5% respectively, and an untreated control sample

were tested for water permeability. Both the treated and untreated samples were subjected to a pressure of 150 psi (350 ft. water head). Results showed moisture and permeated water throughout the untreated sample after 24 hours. However, the Xypex Admix samples showed no leakage, and water penetration of only 1.5 mm after 120 hours (5 days).

U.S. Army Corps of Engineers CRD C48-73, "Permeability of Concrete", Setsco Services, Pte Ltd., Singapore

Six Xypex Admix-treated and six untreated concrete samples were tested for water permeability. Pressure was gradually increased over five days and then maintained at 7 bars (224 ft. water head) for 10 days. While the six reference samples showed water leakage beginning on the fifth day and increasing throughout the test period, the Xypex Admix samples showed no water leakage at any time during the test.

DIN 1048, "Water Impermeability of Concrete", DICTU S.A., Dept. of Engineering and Construction Mgt., Santiago, Chile

Concrete samples 120 mm thick containing Xypex Admix were tested with the same size reference samples for water impermeability. Samples were subjected to hydrostatic pressure for 28 days. Water totally permeated the untreated samples but no water penetration was detected in any of the Xypex Admix-treated samples.

COMPRESSIVE STRENGTH

ASTM C 39, "Compressive Strength of Cylindrical Concrete Specimens", HBT Agra, Vancouver, Canada

Concrete samples containing Xypex Admix at various dosage rates (1%, 2% and 5%) were tested against an untreated concrete control sample. Compressive strength test results after 28 days indicated a significant strength increase in the samples incorporating Xypex Admix. The compressive strength increase varied between 5% and 20% (depending on the Xypex Admix dosage rate) over that of the reference sample.

ASTM C 39, "Compressive Strength of Cylindrical Concrete Specimens", Kleinfelder Laboratories, San Francisco, USA

At 28 days, the compressive strength test of the concrete containing Xypex Admix measured 7160 psi as compared to the reference sample at 6460 psi (a 10% increase).

CHEMICAL RESISTANCE

JIS, "Chemical Durability Test", Japanese Utility Company, In-house Test Report, Tokyo, Japan

Concrete samples containing Xypex Admix were tested against five samples containing other admixtures and against a control sample, to determine resistance to corrosion and deterioration caused by contact with aggressive chemicals. All samples were soaked in a 5% sulfuric acid solution at 20ºC for six months. Various evaluations and measurements were assessed every month during the test period, including: photographic comparisons, relative dynamic modulus of elasticity, percentage change in length, weight and flexural rigidity. Although the Xypex Admix sample was subjected to acid conditions well outside its published range, the results confirmed Xypex with the best performance among the seven samples tested.

"Sulfuric Acid Resistance Test", Aviles Engineering Corporation, Houston, USA

Concrete samples containing Xypex Admix at different dosage rates (3%, 5% and 7%) were tested against untreated control samples for sulfuric acid resistance. After immersion in the sulfuric acid, each sample was tested for weight loss on a daily basis until a weight loss of 50% or a definite response trend was obtained. The percentage weight loss of the samples containing Xypex Admix tested significantly lower than the control samples.

"Sulphate Resistance Test", Taywood Engineering Ltd., Perth, Australia

Xypex Admix-treated concrete samples were immersed in an ammonium-sulphate solution and tested for "resistance in a harsh environment". The performance of the Xypex crystalline technology was compared with five other concretes, including one containing a sulphate-resistant cement. Each of the test samples was cured for seven days and then placed in an ammonium-sulphate solution (132 g/litre) for 180 days. The rate of corrosion was determined by measuring weight loss, and length change was noted on a weekly basis. The Xypex crystalline technology substantially improved concrete performance as compared to the reference concrete and tested very similar to the sulphate-resistant concrete. The Xypex Admix-treated samples also provided the highest level of protection as measured by change in length.

FREEZE/THAW DURABILITY

ASTM C 666, "Freeze/Thaw Durability", Independent Laboratory, Cleveland, USA

After 300 freeze/thaw cycles, the Xypex Admix-treated samples indicated 94% relative durability.

POTABLE WATER EXPOSURE

NSF 61, "Drinking Water System Component-Health Effects", NSF International, Ann Arbor, USA

Exposure testing of potable water in contact with Xypex-treated samples indicated no harmful effects.

Directions for Use

Xypex Admix C-1000 must be added to the concrete at the time of batching. The sequence of procedures for addition will vary according to the type of batch plant operation and equipment:

1. **READY MIX PLANT - DRY BATCH OPERATION** Add Xypex Admix in powder form to the drum of the ready-mix truck. Drive the ready-mix truck under the batch plant and add the balance of the materials in accordance with standard concrete batching practices. Mix materials for a minimum of 5 minutes to ensure that the Xypex Admix has been thoroughly dispersed throughout the concrete.

2. **READY MIX PLANT - CENTRAL MIX OPERATION** Mix Xypex Admix with water to form a very thin slurry (e.g. 15 - 20 lb./6.75 - 9 kg of powder mixed with 3 U.S. gallons/ 13.6 litres of water). Pour the required amount of material into the drum of the ready-mix truck. The aggregate, cement and water should be batched and mixed in the plant in accordance with standard practices (taking into account the quantity of water that has already been placed in the ready-mix truck). Pour the Admix slurry into the truck and mix for at least 5 minutes to ensure even distribution of the Xypex Admix throughout the concrete.

3. **PRECAST BATCH PLANT** Add Xypex Admix to the rock and sand, then mix thoroughly for 2 - 3 minutes before adding the cement and water. The total concrete mass should be blended using standard practices.

NOTE:

i. It is important to obtain a homogeneous mixture of Xypex Admix with the concrete. Therefore, do not add dry Admix powder directly to wet concrete as this may cause clumping and thorough dispersion will not occur.

ii. Concrete containing the Xypex Admix does not preclude the requirement for design of crack control, construction joint detailing and measures for repairing defects in concrete (i.e. honeycombing, tie holes, cracks beyond specified limits).

For further information regarding the proper use of Xypex Admix for a specific project, consult with a Xypex technical services representative.

Setting Time and Strength

The setting time of concrete is affected by the chemical and physical composition of ingredients, temperature of the concrete and climatic conditions. Xypex Admix C-1000 is designed for typical Portland cement-rich concrete, where normal to a mild retarded set is desired. Concrete containing the Xypex Admix C-1000 may develop higher ultimate strengths than plain concrete. Trial mixes should be carried out under project conditions to determine the setting time and strength of the concrete dosed with Xypex Admix C-1000. Consult with a Xypex technical services representative for the most appropriate Xypex Admix for your project.

Limitations

When incorporating Xypex Admix, the temperature of the concrete mix should be above 40ºF (4ºC).

Technical Services

For more instructions, alternative installation methods, or information concerning the compatibility of the Xypex treatment with other products or technologies, contact the Technical Services Department of Xypex Chemical Corporation or your local Xypex representative.

Safe Handling Information

Xypex is alkaline. As a cementitious powder or mixture, Xypex may cause significant skin and eye irritation. Directions for treating these problems are clearly detailed on all Xypex pails and packaging. The Manufacturer also maintains comprehensive and up-to-date Material Safety Data Sheets on all its products. Each sheet contains health and safety information for the protection of workers and customers. The Manufacturer recommends you contact Xypex Chemical Corporation or your local Xypex representative to obtain copies of Material Safety Data Sheets prior to product storage or use.

Warranty

The Manufacturer warrants that the products manufactured by it shall be free from material defects and will be consistent with its normal high quality. Should any of the products be proven defective, the liability to the Manufacturer shall be limited to replacement of the product ex factory. The Manufacturer makes no warranty as to merchantability or fitness for a particular purpose and this warranty is in lieu of all other warranties expressed or implied. The user shall determine the suitability of the product for his intended use and assume all risks and liability in connection therewith.

APPENDIX D
RST INSTRUMENTS INFORMATION

» piezometers

Vibrating Wire Piezometers

The RST Vibrating Wire Piezometer provides excellent long-term accuracy, stability of readings and reliability under demanding geotechnical conditions. Vibrating Wire Piezometers are the electrical piezometers of choice as the frequency output of VW devices is immune to external electrical noise, and able to tolerate wet wiring common in geotechnical applications.

operating principle

Vibrating Wire Piezometers contain a high tensile steel wire with a fixed anchor at one end and are attached to a diaphragm in contact with water pressure at the other end. The wire is electrically plucked, with the resonant frequency of vibration proportional to the tension in the wire. This frequency induces an alternating current in a coil which is detected by the readout unit, such as the VW2106 Vibrating Wire Readout, and can then be converted to a pressure. The frequency output is immune to external electrical noise, and able to tolerate wet wiring common in geotechnical applications. Highly reliable lightning protection is incorporated in the vibrating wire transducer.

The frequency signal is exceptionally immune from cable effects, including length (to several kilometers), splicing, resistance, noise pickup, and moisture. The vibrating wire coil circuit contains no semiconductor devices and has built-in ionized gas discharge device protection against transient damage. As a result, the vibrating wire piezometer provides excellent reliability in typical geotechnical situations – i.e. long outdoor cables buried in saturated soil.

The piezometer is equipped with a standard sintered stainless steel porous filter to prevent soil particles from contacting the diaphragm. A thermistor is built into the piezometer body to permit temperature measurement and temperature compensation of the piezometer. Standard construction is all stainless steel. RST vibrating wire piezometers are shipped with extremely tough polyurethane-jacketed foil-shielded cable for maximum endurance in field conditions.

RST Instruments Ltd.
11545 Kingston St.,
Maple Ridge, BC
Canada V2X 0Z5

Telephone: 604 540 1100
Facsimile: 604 540 1005
Toll Free: 1 800 665 5599

info@rstinstruments.com
www.rstinstruments.com

applications

- Assessing performance and investigating stability of earth fill dams and embankments.
- Slope stability investigations.
- Monitoring water levels in wells and standpipes.
- Monitoring pressures behind retaining walls and diaphragm walls.
- Monitoring pore pressures during fill or excavation.
- Monitoring pore pressure in land reclamation applications.

features

- Field proven reliability and accuracy.
- Will tolerate wet wiring common in geotechnical applications.
- Immune from external electrical noise.
- Signal transmission of several kilometers.
- Cable lengths may be changed without affecting the calibration.
- High accuracy, IE a low pressure vented model will measure water level changes as small as 0.5 mm (0.02 in.).
- Thermistor for temperature measurement is standard.
- Negligible displacement of pore water during the measurement process.
- Hermetically sealed, stainless steel construction.
- Heavy case to minimize reading errors caused by overburden pressure.
- Data logger compatible.
- Integral lightning protection.

GEOTECHNICAL • MINING • ENVIRONMENTAL • STRUCTURAL

ISO 9001

specifications + ordering info

Vibrating Wire Piezometers

vibrating wire piezometer specs

DESCRIPTION	SPECIFICATION
Over range	2 X F.S.
Resolution	0.025% F.S. minimum
Accuracy	0.1% F.S.
Operating Temperature	-20 to 80°C (-4 to 176°F)
Diaphragm Displacement	<0.001 cc at F.S.
Thermal Zero Shift	<0.05% F.S./°C
Materials	Hermetically sealed stainless steel housing
Thermistor Type	NTC 3K Ohms @ 25°C
Thermistor Interchangeability	±0.2°C
Thermistor Resolution	0.1°C
Filter	50 micron sintered filter. (High air entry alumina filter 1, 3, 5 Bar available)

vibrating wire piezometer options

- Heavy-duty bodies for embankment use.
- Push-in drive points for soft soils
- High air entry ceramic filters to exclude air
- Low range and vented piezometers
- Titanium construction for use with corrosive fluids
- Multi-point mixed type sensor strings
- Kevlar® reinforced cable

optional equipment

- VW2106 Vibrating Wire Readout
- Dataloggers
- Terminal stations
- Electrical cable
- Cable splice kits
- Installation geotextile and socks
- Increased lightning protection

electrical cable specs

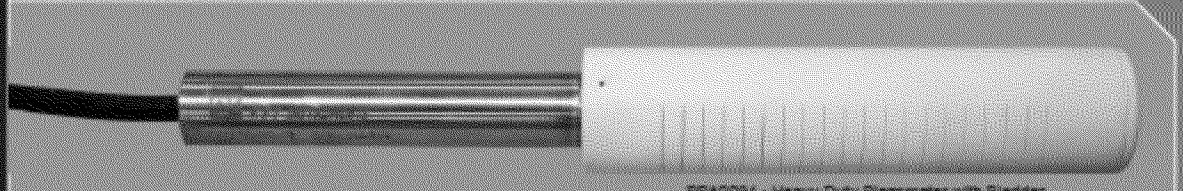
PART #	DESCRIPTION
EL380004	Two twisted pairs cable with polyurethane jacket.

Other types of cables, depending on site conditions and atmospheric reference requirements, are available upon request.
These include vented, FEP, PVC, polyurethane, and armored varieties.

ordering info

PART #	DESCRIPTION	PRESSURE RANGE	DIMENSION
VW2100	Standard model for general applications.	0.35, 0.7, 1.0, 2.0, 3.0 MPa	19 mm Ø X 130 mm
VW2100-HD	Heavy duty piezometer for direct burial in fills and large dam embankments.	0.35, 0.7, 1.0, 2.0 3.0, 5.0, 7.5, 10 MPa	25.4 mm Ø X 146 mm
VW2100-XHD	Heavy duty piezometer for direct burial in fills and large dam embankments.	1.0, 2.0 3.0, 5.0, 7.5, 10 MPa	38.1 mm Ø X 146 mm
VW2100-HHP	High pressure transducer with NPT port.	5.0, 7.5, 10, 25, 50, 75, 100 MPa	25.4 x 143 mm
VW2100-DP	Drive point model with CPT adapter.	0.07, 0.175, 0.35, 0.7, 1.0, 2.0, 3.0, 5.0, 7.5 MPa	33 mm Ø X 432 mm
VW2100-L	Low Pressure, unvented.	70, 175 kPa	25 mm Ø X 133 mm
VW2100-LV	Low Pressure vented.	70, 175 kPa	25 mm Ø X 133 mm
VW2100-M	Miniature version – 17.5 mm diameter.	0.35, 0.7, 1.0, 2.0, 3.0 MPa	17.5 mm Ø X 133 mm
VW2100-MM	Micro-miniature version – 11.1 mm diameter.	0.35, 0.7 MPa	11.1 mm Ø X 165 mm
PPA0094	Heavy duty piezometer with bladder.	0.35, 0.7, 1.0, 2.0 3.0, 5.0, 7.5, 10 MPa	25.4 mm Ø X 146 mm Bladder O.D.: 1.65 in

High temperature models and metallic cable are available by special order. High temperature ranges include: 0 to 100°C; 0 to 150°C; and 0 to 200°C.



PPA0094 - Heavy Duty Piezometer with Bladder

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» readouts | dataloggers | terminal stations

DT2055B Ten Channel Data Logger

The DT2055B Ten Channel Data Logger is a low cost, battery powered data logger, designed for reliable, unattended monitoring of up to 10 sensors which may be any mix of vibrating wire sensors and thermistors, typically 5 vibrating wire sensors with their associated thermistors.

It is a purpose built logger ideal for remote locations or instruments that require frequent reliable data recording. It connects to all vibrating wire sensors including piezometers, crack meters, and strain gauges. However, the DT2055B Ten Channel Data Logger will not connect to vibrating wire sensors with auto resonant circuitry.

Vibrating wire sensors have unique advantages in geotechnical applications, as the frequency output of the gauge is immune to external electrical noise, able to tolerate wet wiring without signal degradation, and able to transmit the signal up to 1.6 kilometers without loss.

Data logger setup and data collection is done using the Ultra-Rugged Field PC* or a laptop. Multi-Channel Host Software is also included.

A single gland option (DT2055B-T) is also available for Multi-point Vibrating Wire Piezometer Strings or Thermistor Strings.

As shown here, the DT2055B can also be equipped with an optional radio antenna (L900) to incorporate it into an rstar wireless system. RST's rstar system uses wireless technology to provide continuous data acquisition.

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Maple Ridge, BC
Canada V2X 0Z5

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applications

Ideal for applications that require reliable, unattended monitoring of up to five vibrating wire sensors.

features

HARDWARE

- Option for radio antenna for incorporation into an RST rstar wireless system for acquiring data.
- Robust construction.
- 4MB memory.
- Weather resistant NEMA 4X (IP65) enclosure.
- Battery powered for remote sites.
- 100 year memory backup.
- Compatible with all VW sensors – excluding those with auto resonant circuitry.
- -40°C to 60°C (-40°F to 140°F) operating range.
- 0.01με vibrating wire resolution.
- 16 bit analog/digital converter.

SOFTWARE

- User friendly Windows® host software included at no additional cost.
- Compatible with most spreadsheet software.
- Data stores in CSV format and opens in Microsoft® Excel.

ISO 9001

ISO 9001 GEOTECHNICAL, MINING, ENVIRONMENTAL, STRUCTURAL

specifications + ordering info

DT2055B Ten Channel Data Logger

general specifications

DESCRIPTION	SPECIFICATION
Frequency Accuracy	0.01% Full Scale
Resolution	1 part in 65,000
Memory	Over 120,000 records including: time, 5 channels frequency, frequency², 5 channels temperature
Power Source	1 'D' lithium primary battery
Battery Life	Over 5 years / 2 memory fills depending on temperature and use
Communication	USB type B connector
Dimensions	120 x 102 x 91 mm (4.7 x 4.0 x 3.6 in.)
Temperature Range	-40°C to 60°C (-40° to 140°F)
Enclosure	NEMA 4X (IP65)

data storage specifications

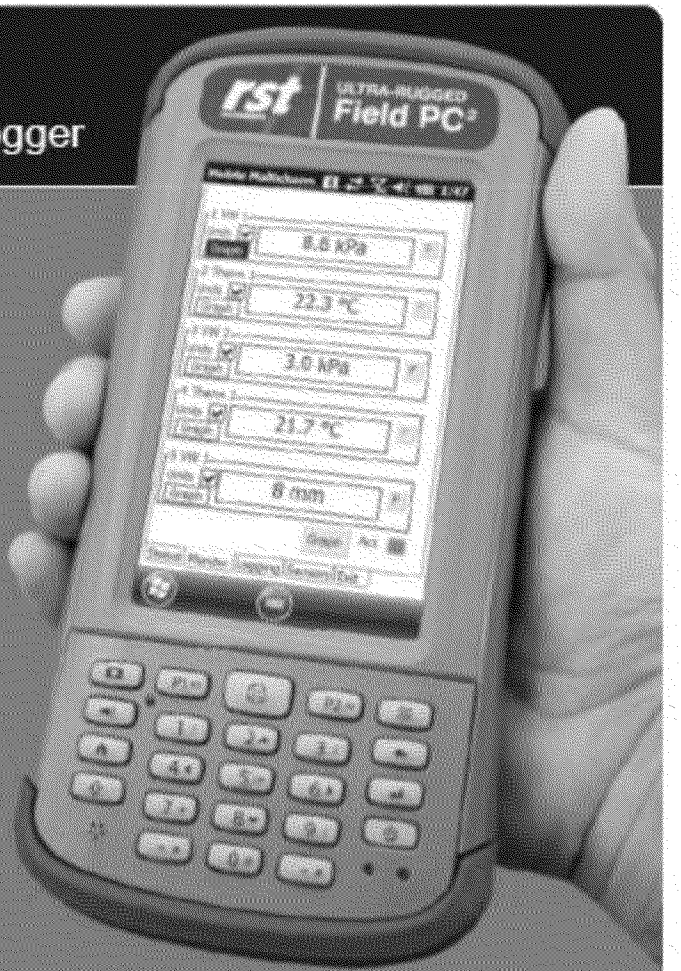
DESCRIPTION	SPECIFICATION
Memory	4 MB
Data Transfer	5,000 data points per second
Interval Mode	10 seconds to 1 day
Variable Rate Mode	16 user programmable sampling rates
Time Format	Month / day / year Hour / minute / second
Memory Full Behaviour	"Wrap around" or "fill & stop" option

optional equipment

Communications cable
LR30 radio option

ordering info

PART #	DESCRIPTION
DT2055B	Ten Channel Data Logger
DT2055B-T	Ten Channel Data Logger - Single Gland
IC32000-ARG-RST3	Ultra-Rugged Field PC³



Setup the data logger and collect data using the Ultra-Rugged Field PC³.

Screenshot of DT2055B Mobile software as shown on the Ultra-Rugged Field PC³.

Ten Channel Data Logger with Single Gland; optional connector available, contact RST for complete details.

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Appendix D

Site Specific Data Management Plan

	This data management plan (DMP) is intended to provide guidance for data collection by field personnel and subsequent data management activities. The data collection and management practices presented in this plan are designed to ensure data integrity and consistency for all data collection personnel and from operational period to the next. This document is intended to be used in conjunction with the Region 8 Data Management Plan and only includes the details specific to the site.	**Site-Specific Data Management Plan**			
		Project Name:	Red and Bonita Removal	**TDD Number/Site ID:**	0001/1502-03
		Author:	Elliott Petri	**Company:**	Weston Solutions
		Date Initiated:	May 7, 2015	**Last Updated:**	May 15, 2015
Reviewed by: Jamie Miller			**Date: 5/8/2015**		

Data Processing

The following table outlines the specific requirements for various data types being collected during the project.

	Data Stream	Site Specific Procedure (Y/N)*	Required Information	Data Source	Site Specific Data Elements (Y/N)	QA Process	Data Repository	Reporting Task
1	Water Sampling Data	Y	*Field parameters from water quality meter*	Log Book, Water Quality Meter	Y (Attachment A)	Field review	Scribe.net	Site Activities Report
2	Geospatial Data	Y	*Verify sampling locations from historical sampling efforts.*	Basic GPS	Y (Attachment A)	Verify coordinates match with historic coordinates.	Field Notes for verification on viewer.	Geospatial Viewer
3	Images	N	*Site photos*	Digital Camera	N	Field Personnel Review	EPAOSC.org	Site Activities Report
4	Site Documents	N	*SAP Addendum, HASP*	START Network	N	PTL and OSC Reviews	EPAOSC.org	NA
5	Analytical Data	N	*Chain of Custody, Laboratory Data from a commercial laboratory.*	Scribe, Laboratory EDD	N	Review by field personnel prior to import to ensure all required fields are present and data maps accurately into scribe database	Scribe.net	Results Report, Geospatial Viewer
6	Concrete Testing Results	Y	*Subcontractor report with strengths, slump test results, and air entrapment results*	Subcontractor Report	Y	Review by reporting personnel.	EPAOSC.org	Site Activities report
7	Project Costs	N	*Field Costs, Personnel Hours*	RCMS database	N	PTL Review	1900 -1955 Forms	Email to OSC

* Y – indicates a site specific procedure is employed, N – indicates data management follows procedures outlined in the R8 DMP

Attachment A
Site Specific Data Elements and Valid Values

Ref. Project: Red and Bonita Removal **TDD:** 0001/1502-03 **Date:** **5/15/2015**

Data Stream	Data Element	Required	Description	Format	Scribe Table.Field	Valid Values* or Input Mask
All sampling events	EventID	Yes	Identifier to distinguish between sampling events	Alphanumeric	Events.EventID	Sample ID will include date data since multiple sampling events are planned.
Water Sampling (Grab Samples, Flowrates)	Matrix	Yes	Water matrix	Valid Values/ Picklist	WaterSampling.Matrix	Matrix: Water - Surface
	Sample Number	Yes	Sample Identifier	Alphanumeric	SoilSampling.Samp_No	Sample ID's will correspond to historical Sample ID's.
	Sample Location	Yes	Sample Location	Alphanumeric	SoilSampling.Location	Verify location via GPS with historical sampling location.
Geospatial Data	Location	Yes	Coordinate	Alphanumeric	Location	Latitude/longitude
Images	Metadata	Yes	Time/Date, Description	Alphanumeric	Time, Date, Description	Will be recorded in a photo log to document project, may be transcribed to EPAOSC.org. Photo locations will be georeferenced when satellite coverage is available.
Concrete Testing Results	Strength	Yes	Resulting strength (psi or kps) of concrete.	Alphanumeric	NA	PSI or KSI
	Sample Number	Yes	Sample Identifier	Alphanumeric	NA	Third Party Numbering System
	Curing Time	Yes	Time from concrete pour to test	Alphanumeric	NA	Days

* Fill in additional site specific data elements/ valid values if identified in the field

NOTE: This table is meant to provide detailed guidance for the collection of field data to be housed in the site scribe database. This table ensures site data is collected consistently across field teams and field events. This table exists in the Region 8 DMP with all of the default data elements and valid values. You only have to fill out this table for data elements and valid values that are specific to your site. You may copy in lines that are especially important for your site data management or specify where you only want to use a limited list of the general valid values.